

G. V. Black's Work on operative dentistry : with which his Special dental pathology is combined / revision by Arthur D. Black.

Contributors

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IV
PATHOLOGY
TREATMENT

INVESTING TISSUES
DENTAL PULP
PERIAPICAL TISSUES
FOCAL INFECTION


BLACK



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Dr. G. V. Black and a Tree Friend on Cheyenne Mountain

This photograph of Dr. G. V. Black reflects his love for nature, which was gained during his early boyhood as the son of a pioneer farmer in Central Illinois. It was taken by Dr. Frederick S. McKay on the occasion of Dr. Black's visit to Colorado Springs, Colorado, in 1909 to study mottled teeth. Dr. McKay took Dr. Black for a drive on the old stage road which led from Colorado Springs to the famous Cripple Creek gold mines, and a stop was made as the road wound around the face of Cheyenne Mountain south of Colorado Springs, where the photograph was taken.

Dr. McKay writes under date of September 15th, 1936: "This was one of the earliest episodes in connection with Dr. Black's interest in the study of mottled teeth, the last subject in dental research in which he was interested. As a result of his visit, the first article in dental literature on Mottled Enamel was written. It was published in the Dental Cosmos in 1916."



G. V. BLACK'S WORK
ON
OPERATIVE DENTISTRY

with which his
SPECIAL DENTAL PATHOLOGY
IS COMBINED

PUBLISHED IN FOUR VOLUMES

VOLUME FOUR

DISEASES AND TREATMENT

INVESTING TISSUES OF THE TEETH
AND OTHER SOFT TISSUES OF THE MOUTH

THE DENTAL PULP

THE PERIAPICAL TISSUES

FOCAL INFECTION

GLOSSARY FOR THE FOUR VOLUMES.

523 ILLUSTRATIONS

REVISION BY

ARTHUR D. BLACK, A.M., M.D., D.D.S., SC.D.

DEAN AND PROFESSOR OF OPERATIVE DENTISTRY AND ORAL PATHOLOGY
NORTHWESTERN UNIVERSITY DENTAL SCHOOL

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Special Dental Pathology

Introduction

THIS volume is a revision of the work by G. V. Black, entitled *Special Dental Pathology*, the first edition of which was published in 1915. It covers the same ground as the original work, and is devoted to the pathology of the investing tissues of the teeth and of the dental pulp, also the sequellae of pulp death. While these diseases are in many respects similar to those occurring in other parts of the body, they constitute a distinct class, involving problems unlike those found elsewhere. This is particularly true of the conditions which contribute to the establishment and maintenance of chronic foci of infection. The lack of understanding of these peculiar conditions has undoubtedly contributed greatly to the wide differences of opinion regarding both the pathology and treatment, as well as the determination that teeth should be extracted.

This volume represents a considerable group study over a period of more than fifty years, beginning with Dr. G. V. Black's book on *The Formation of Poisons by Micro-Organisms* in 1884, his chapters on the *Pathology of the Dental Pulp and the Diseases of the Peridental Membrane* in the *American System of Dentistry* in 1886, and the publication of his book entitled *A Study of the Histological Characters of the Periosteum and Peridental Membrane* in 1887.

The work has progressed continuously, with changes in the personnel of the group as the years have passed. G. V. Black, with whom Frederick B. Noyes and Herbert A. Potts were closely associated in the earlier studies, had by 1915 set the stage for the continuation of this work. During the past twenty years, Edward H. Hatton, pathologist, and William G. Skillen, histologist, have cooperated with F. W. Merrifield, G. R. Lundquist and the author, who have given particular attention to the clinical aspects of the studies. Advantage has been taken of researches by many others.

In the fields of histology, pathology and bacteriology, tremendous progress has been made in the study of dental problems in recent years. This has been a natural result of the development of the principle of focal infection and the high incidence of original foci in the mouth. An analysis of the tissue reactions, as observed clinically and verified by laboratory study, seems to justify a very logical program of treatment by which nature is aided in the elimination of these infections.

The effort has been made to so systematize the treatment of the various pathological conditions, that one may make a rather definite prognosis in each case. Prolonged treatment and the considerable use of drugs is largely replaced by definiteness of action and almost immediate results in the large majority of cases.

Two chapters are new; one on *pressure pericementitis*, the other on the *diseases of the soft tissues of the mouth*. The chapter on pressure pericementitis represents an attempt to so analyze the tissue changes which occur as a result of excessive occlusal stress, that better understanding of the conditions and tissue reactions will point the way to the most effective treatment.

NOMENCLATURE

Pressure Pericementitis is applied to an inflammation of the periodontal structures resulting from excessive occlusal stress. Usually the tooth is tipped in its socket beyond its *functional range*, resulting in compression of the periodontal membrane and resorption of bone on the *pressure side or region*, and a straightening of the fibers or stretching of the periodontal membrane with formation of new bone on the *traction side or region*.

The word *apical* is used with *pericementitis*, or *periapical* with some other term to designate inflammations resulting from pulp death, as *chronic apical pericementitis*, *chronic periapical abscess*.

The word *pericementitis* is applied to inflammations beginning in the gingival region, as *pressure pericementitis* and *chronic suppurative pericementitis*.

Cemental line is used to indicate the dento-cemental junction, and *gingival crevice* the space between the gingiva and the enamel.

A *Glossary of Technical Terms* is appended to this volume. It includes the terms used in all four volumes of this work.

In addition to the acknowledgments in the preface of Volume I, the author wishes to further express his appreciation of the assistance and cooperation of the following confreres:

To Dr. George B. Denton for the preparation of the historical reviews of the diseases and their treatment, presented in two chapters; one on the investing tissues of the teeth, the other on the dental pulp.

To Dr. Edward H. Hatton, not only for the chapter on Focal Infection, which includes a masterly analysis and criticism of the studies of this complicated problem by many investigators, but also for many other contributions to both the text and illustrations throughout this volume, drawn from his wide experience in the fields of dental pathology and bacteriology.

To Dr. W. G. Skillen for supplying much of the new histological data and illustrations, which reflect his many years of study in this field.

To Dr. G. R. Lundquist, the author's teaching associate for the past twenty years, for many of the illustrations presented in demonstration of clinical results obtained by the methods of treatment recommended, also for his greatly valued assistance in the preparation of the text.

In a few instances credit is given in the text for these contributions; more often they are not specifically mentioned.

INVESTING TISSUES OF THE TEETH

Physical Functions and Physiological Relations

BIBLIOGRAPHY ON INVESTING TISSUES PAGE 265

ILLUSTRATIONS: FIGURES 1197-1281.

IN ORDER that one may understand and rationally treat the diseases of the investing tissues of the teeth it is quite essential that one should have a clear understanding of the physiology of the several tissues, and their physiological and pathological relations to the tissues with which they are directly connected. One should know how these act and react toward each other and the limitations of their powers in recuperation following disease or accident. If these are well understood, it will be comparatively easy to comprehend the pathological conditions, their symptomatology, and what may and what may not be accomplished in treatment. Knowledge of what can not be done is quite as important in practice as knowledge of what can be done.

A general statement of the development of the teeth and the investing tissues is presented in Volume I, accompanied by a series of seventeen illustrations, 9A to 9R, most of which are diagrammatic. One of these, a mesio-distal section through a lower first molar is reproduced here as Figure 1197. Frequent references will be made to this illustration.

The development of the investing tissues of the teeth should not be considered apart from the formation and eruption of the teeth themselves, as the two are quite inseparable from the time of the beginning formation of the roots throughout the existence *in situ* of each tooth. In fact, it is rather difficult to draw a sharp line between the tissues which constitute the tooth and those which may be considered as the investing tissues. The cementum, which covers the dentin root, is a part of the tooth, yet it is very definitely a part of the attachment mechanism which supports the tooth. It is laid down on the root by cells of the peridental membrane as an anchorage for the fibers which attach the tooth to the bone, and its continued vitality is dependent upon the health of the pericemental tissues.

The entire attachment mechanism, consisting of the cementum, peridental membrane and bone of the alveolar process, develops as a natural sequence of the lengthening of the root and the eruption of the tooth. The formation of the gingivæ also occurs in connection with the eruption of the tooth. The tissues of the tooth and those which invest and support it, must be considered as a single coordinated mechanism, the various elements of which are mutually interdependent.

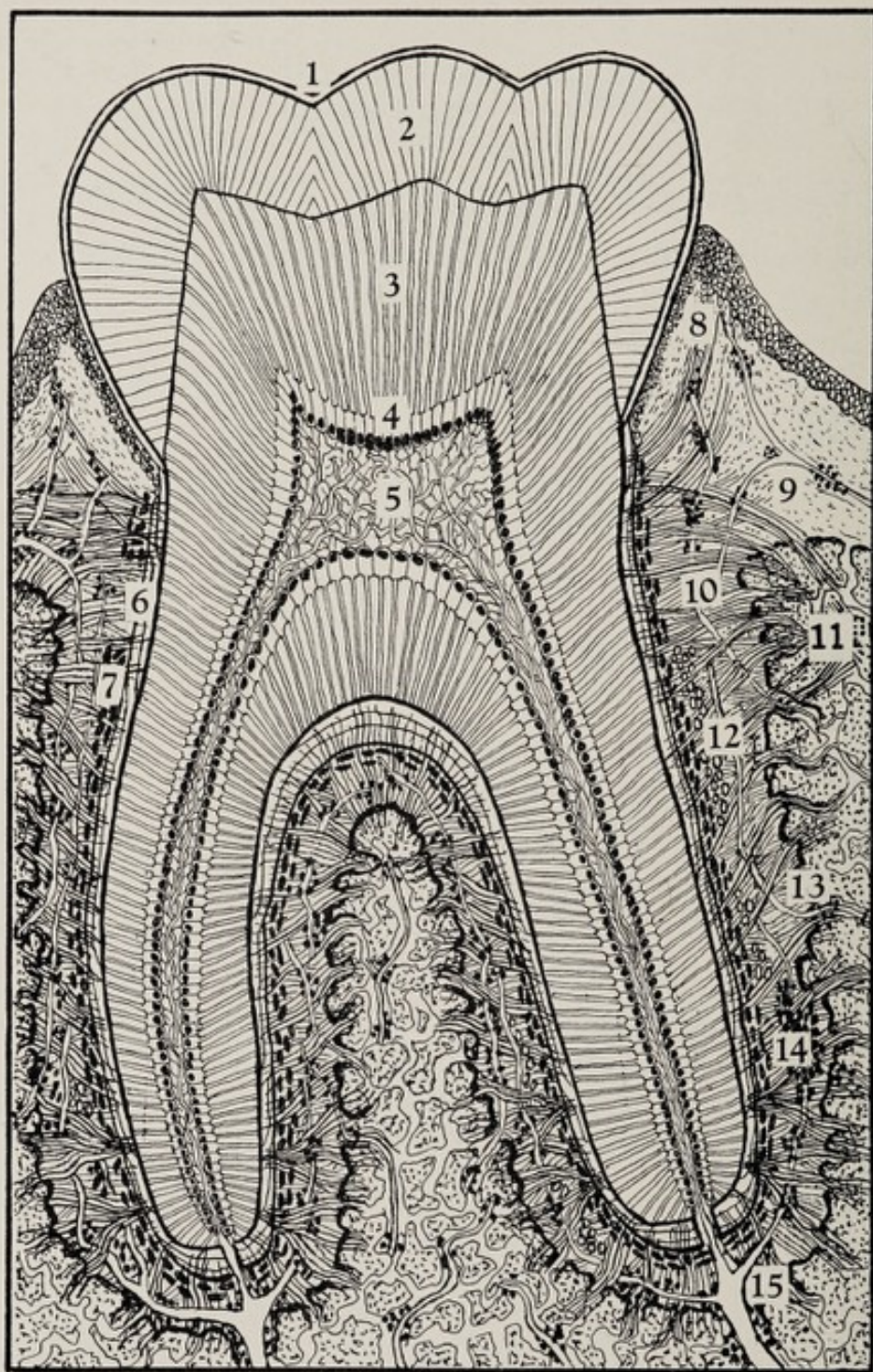


FIG. 1197. Drawing illustrating the various structures of the tooth and its supporting tissues; a mesio-distal section through a lower first molar. Sixteen other illustrations of the development of this tooth are shown in Volume I, Figures 9A to 9R.

Explanation: 1, enamel cuticle; 2, enamel; 3, dentin; 4, odontoblasts; 5, pulp; 6, cementum; 7, cementoblasts; 8, gingiva; 9, blood vessel from gum to periodontal membrane; 10, principal fibers of periodontal membrane; 11, bone of alveolar process; 12, epithelial cells close to cementum; 13, blood vessel from bone to periodontal membrane; 14, lymphatic vessels attached to blood vessels; 15, blood vessel from apical region into periodontal membrane.

The various groups of fibers of the periodontal membrane may be differentiated: Those of the gingival group terminate between the figures 8 and 9; the fibers of the trans-septal group may be seen above the figure 6, extending mesially toward the distal surface of the root of the second bicuspid; those of the alveolar crest group terminate above the figure 11; the figure 10 indicates the horizontal group; the figure 12 indicates the oblique group which includes all of the fibers between the horizontal and apical groups; the fibers of the apical group may be seen from a point a little below figure 14, surrounding the apex of the root.

It will become evident, as the pathology of the investing tissues is discussed, that the preservation of the health of the gingivæ is of as great or even greater importance than the control of caries, in the conservation of the teeth. This is due to the fact that practically all of the diseases which involve these tissues, except those which result from the death of the pulp, begin as inflammations of the gingivæ.

The first comprehensive study of the histology and physical functions of these tissues was written by G. V. Black and published in a series of eight articles in the *Dental Review*, 1886-87, and subsequently in book form in 1887 under the title: "A Study of the Histological Characters of the Periosteum and Peridental Membrane."* This book consists of 138 pages, with 67 illustrations which are very excellent india ink drawings made from microscopic specimens of the tissues with the camera lucida. This was before the days of photomicrographs. All of these original drawings are preserved. They were reproduced in the several editions of the *Special Dental Pathology* and a few are included here.

The Gums and Gingivæ

ILLUSTRATIONS: FIGURES 1197-1222

The gums clothe the alveolar processes and the hard palate; the gingivæ invest the gingival portions of the crowns of the teeth.† These divisions of tissue join each other by continuity without apparent demarcation at the level of the cemental line of the several teeth. There is nothing on the surface to indicate a change in the character or quality of the tissue. The soft tissue passes across between the adjoining teeth, through each interproximal space, and unites the soft tissues covering the buccal and labial parts with the lingual parts, thus encircling each tooth. The gingivæ have tissue characters and functions not possessed by the gums. It seems best to describe the characters common to both first and then, under more specific definitions, to describe the gingivæ.

The gums consist of soft tissue of compact inelastic firmness, which spreads from the cementum occlusally of the alveolar processes and covers the alveolar ridges well down and away from the teeth in all directions. Then a change in character to a soft mucous membrane occurs, which is reflected on the labial and buccal portions as the mucous membranes of the lips and cheeks from both

* *Dental Review*, Vol. I, 1886-87, pp. 1, 57, 113, 169, 233, 289, 353, 411. This book was published by the W. T. Keener Co., Chicago, and after a limited number of copies had been sold, the remainder were destroyed by a fire which consumed the warehouse in which they were stored.

† In the previous editions of the *Special Dental Pathology*, the dividing plane between the gingivæ and peridental membrane was placed at the level of the crest of the bone of the alveolar process. Most of the present day histologists seem to prefer to place this plane at the level of the cemental line. There are good reasons for either plan of describing these tissues and, to avoid confusion, the latter plan is used in this publication.

the upper and lower arches. On the lingual side of the lower jaw, the mucous membrane covers the hard portions passing into the soft flexible mucous membrane of the floor of the mouth. In the upper jaw the dense membrane spreads over the entire palatal surface, back as far as the junction of the hard and soft palates. This hard inelastic tissue is known as the gums. Curiously enough, the plural form of the word is generally used, though the singular, *gum*, will be heard occasionally when the reference is to some particular spot. The term *gum tissue* is also used in the singular form.

THE FIBROUS MAT. The basis of the gum tissue is a thick mat of inelastic fibers. Many of these fibers are large and are branched and connected in every direction in rather short lengths, forming a dense network, or mat. The periosteum, which is very firmly at-

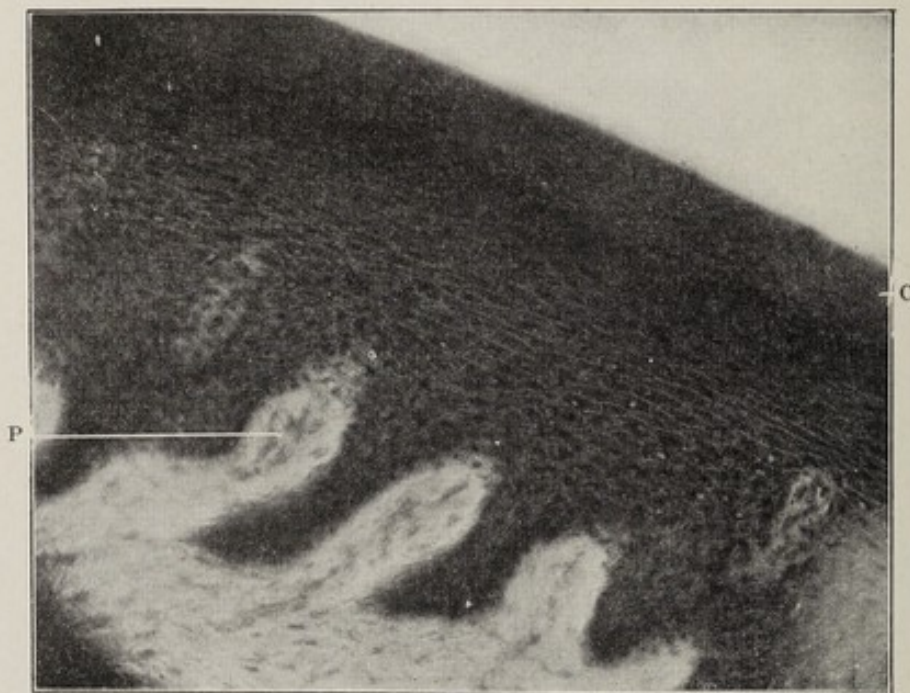


FIG. 1198. Stratified squamous epithelium covering the alveolar process: c, Corneous layer. P, Papilla of connective tissue. Noyes.

tached to the bone over this region, is also very closely interwoven with this fibrous network. In this union the two tissues retain their identity. That is, the periosteum retains its usual closely coherent form, and the fibrous mat of the gum tissue also retains its form, but the two are so united by interlocking of fibers as to prevent sliding movements of the one upon the other or upon the bone. This gives the parts their characteristic hardness and immobility.

One should have a clear understanding of the difference between such an immobile tissue and a very mobile tissue. If two fingers of one hand are placed on the back of the other hand and if, while pressing firmly, the fingers are moved as far as the sliding of the skin will allow and the skin is thus moved back and forth, it will be noticed that it will slide considerably. This will differ

much in different individuals; in some it will move an inch or more, in others less. The pulps of the palmar surfaces of the fingers are rather soft masses of tissue. If the pulps of the two middle fingers are placed together and moved upon each other with firm pressure, it will be noticed that this tissue, while soft and elastic, is comparatively immobile—much more immobile than the skin on the back of the hand. The gums are generally immobile. To demonstrate this, one may dry any part of the gum with a piece of gauze and place the dry finger upon this spot, and try to move the tissue upon itself. One can not slide it at all. This quality of the tissue is so characteristic that it can not be missed in any examination of the regions named. These characteristics extend to the gingivæ in most of their parts, and may be said to be common to the two divisions of tissue.

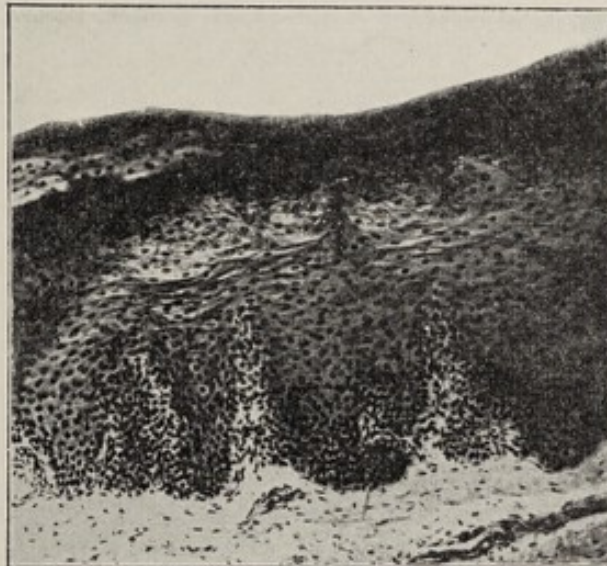


FIG. 1199. Stratified squamous epithelium from unattached mucous membrane of the mouth. The corneous layer is absent. *Noyes*.

EPITHELIUM. The whole of this region has a covering of strong pavement, or squamous epithelium. In most parts the tissues beneath are quite closely interdigitated into this epithelium, giving it a very firm hold, so that it is not easily scraped away.

Wherever the submucosa is firmly attached to the periosteum, the epithelium has a corneous outer layer, as illustrated in Figure 1198, which is a section of gum tissue overlying the alveolar process. It is the same over the hard palate. The epithelium covering the unattached mucous membrane of the mouth, as illustrated in Figure 1199, does not have the corneous layer.

BLOOD VESSELS AND LYMPHATICS. The blood vascular system, as everywhere in the mouth, is rich, and especially so in the capillary circulation. The blood vessels will be found everywhere in the tissue, winding in every direction among the interlacing white fibers. Accompanying the blood vessels are minute perivascular

lymphatics; there are also a number of soft connective tissue fibers and cells filling in the interstices of the coarser fibrous mat.

SENSATION. The gum tissue is generally not very sensitive to painful impressions, though its sense of touch is fairly good. Its lack of sensitiveness to pain that would ordinarily be caused by the forcible movements of rough material over it is very striking when it is in normal condition. This is one of the curious phenomena of nature, stipulated and arranged for a purpose. This tissue, richly endowed with blood and nerves, lies on a surface where foreign substances are very frequently in contact with it, and yet as compared with most of the other tissues, it is markedly insensitive to these. The gingivæ have the same characteristics in all of their parts.

These defensive tissues, hard and rugged, not easily torn, bruised or lacerated, are placed on either side of the dental arches and are intertwined about the teeth. If these tissues, even though hard, were very sensitive, as their blood supply and their nerve supply would lead one to infer, pain would be felt from scrapings of many of the foods which are forced harshly over their surfaces in mastication. Their toughness saves them from real injury, and their insensitiveness protects against pain in chewing food.

Particular attention is called to the fact that the very insensitive gum tissue may be aroused to extreme sensitiveness, especially by those conditions in which it is continually irritated. This is prominently manifested at points upon which an artificial denture binds too hard and is frequently being moved, or moves back and forth. Such points are particularly apt to become hypersensitive.

It should be remembered that under all ordinary conditions the principal function of the gum tissue is defensive. It is not very subject to diseases except as these are communicated by disease of contiguous parts. It is not a tissue which in general requires much attention from the dentist.

HEALING POWERS. In spite of the hardness and rigidity of the gum tissue, it will sometimes be lacerated in the crushing of hard substances over it. The rich blood and nerve supply is at hand to repair such breaks in the most speedy manner possible. Further, the nature of the tissue itself as to its inflexibility is such as to hold the parts in apposition instead of allowing them to spread apart, as most of the soft tissues are inclined to do when cut or torn.

There are conditions of inflammation and swelling, which tend, for the time, to obliterate these characters. In larger injuries, especially when the tissue has been torn away from the bones, there is the opposite tendency to draw away. But even in the lancing of an acute alveolar abscess, where the tissues are inflamed, swollen, and where considerable amounts of pus are discharged through the cut, the surfaces are likely to reunite very promptly unless a drain is placed.

The Gingivæ

The gingivæ comprise the soft tissue which rests upon the peridental membrane and gum tissue, and include the septi which pass between the teeth. Normally the gingivæ extend occlusally from the cemental line and are supported by the fibers of the peridental membrane which are attached to the cementum near the cemental line and pass occlusally within the gingivæ.

The height, or extension occlusally from the cemental line, becomes less with advancing years and, in the mouths of many persons, the gingivæ as a whole recede without apparent inflammatory reaction. This recession may occur on one surface of a tooth, on one or more surfaces of many teeth, or circumferentially about all of the teeth. This may continue until the crests or margins of the gingivæ are below the cemental line of the teeth, so that the cementum is exposed to view. In such cases, the gingivæ continue to occupy the same relation to the peridental membrane and gum tissue, and have a lining of epithelium which corresponds to that of the gingivæ in their normal position.



FIG. 1200. Physiological recession of gingivæ. Patient, age 55. *Lundquist.*

Figure 1200 is a photographic reproduction of the teeth and gums of a man 55 years old, who had had for a number of years a gradual physiological recession of the supporting structures. This is an unusually fine case of a mouth kept in good health by vigorous use. This man stated that he had never used a tooth brush nor any other artificial means of cleaning his teeth or mouth. There were no deposits of any kind and nothing was done in preparation for the taking of the photograph. In view of the fact that a tooth brush had never been used, it is interesting to note that most of the teeth show some erosion; in a few the cutting is fairly deep.

The gingivæ join with the gum tissue without demarcation on the buccal, labial and lingual sides of the crown. They also rise about the teeth from the plane of their attachment in a border passing completely around each tooth and covering more or less of the gingival portion of the enamel surface of the crown. This border normally thins away to a knife-edge that lies very close against the surface of the enamel, but may readily be lifted from

the enamel with a very thin flat instrument, disclosing the gingival crevice between this border and the tooth.

The gingivæ may be conveniently divided into parts by naming the surfaces of the crown of the tooth against which they are imposed; viz., the *buccal gingiva*, the *labial gingiva*, the *lingual gingiva*. That portion which occupies the interproximal space is the *septal gingiva*. The term *gingival crevice* is given to the space between the free gingiva and the enamel which it covers.

DEVELOPMENT OF THE GINGIVÆ.

When a child is born a *primary alveolar ridge* is present, which is serving as a housing for the developing teeth. When a new tooth makes its way to the surface, this primary alveolar ridge

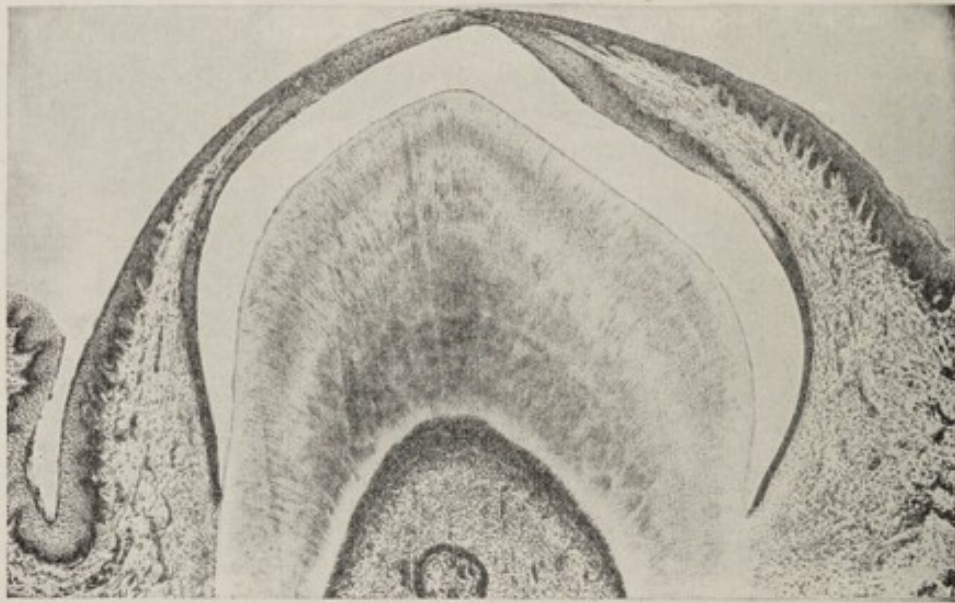


FIG. 1201. A photomicrograph showing the beginning of the formation of the gingivæ as the tooth erupts (in this case a temporary molar), the enamel epithelium joins with the mouth epithelium and the gum tissue gradually recedes about the sides of the crown to form the gingivæ. *Meyer's Histology; Churchill.*

about it is resorbed to give it exit, and an alveolar process of bone begins to form around it. The soft tissue covering of this is simple gum tissue. There is no appearance as yet of the body or processes of the gingivæ. However, just previous to the eruption of the tooth, the enamel epithelium unites with the epithelial covering of the gum, as illustrated in Figure 1201. As the crown of the tooth is pushed forward, a considerable portion of the gum tissue is resorbed to permit the tooth to erupt. There is no exposure of connective tissue, as the enamel epithelium and gum epithelium are always united for a considerable distance on all sides of the opening. This union of the epithelium is the beginning formation of the gingivæ. The tooth moves forward quickly, so that within a very few days it is finding its occlusion with its fellow of the opposite arch. In this last rapid movement any part of the gum tissue in the way is pushed aside. This often gives the soft tissue

about the newly erupted tooth a ragged appearance for a few days. These tissues seem to be overfull and swollen; the embrasures may be crowded with the soft tissue which may stand out in festoons. The child may complain of some transient pain from biting food upon this, but within a few days it is changed to better dimensions by condensation and resorption.

The proper forms and structure of the gingivæ have not yet developed. There is not only resorption, which reduces the surface form of the tissue, but also resorptions everywhere *within the tissue* and growth of those tissue forms belonging to the gingivæ proper. The changes which take place in these tissues during this period are very rapid. It is repetition after repetition of this process, with but little variation, from the time of the eruption of the first of the temporary teeth until the last of the permanent teeth.

During the growth of the outward forms, the fibers of the peridental membrane extend into the newly formed gingivæ to give them support. The gum tissue, with its coarse fibrous mat, is changed for a finer network united with the fibers from the peridental membrane.

Finally, while all of this is in progress, the epithelial covering of the gingivæ is changing. Indeed, this tissue is being actively regenerated during life, but during this time it is rapidly changing its qualities and forms. The cells become smaller and more closely interwoven, while the mass of cellular elements become more and more thickened. There occurs an interdigitation of fine, closely set connective tissue fingers into this epithelium and every part of the tissue is brought into complete form.

As growth proceeds, more and more of the crown of the tooth protrudes through the gingiva and the height of the gingiva is diminished. The changes go on continuously to the adult period. The tissue is trimmed down here and its fullness increased there until an even smoothness of form is produced in the whole compound of soft and hard tissues which gives a smooth exterior with an intimate network of soft tissues wound about the teeth.

The fibers of the peridental membrane, which are distributed into the gingivæ, into the adjacent gum tissue and into the crest of the alveolar process, serve to bind the whole group into a compact mass that has a very powerful controlling effect upon the establishment of the dental arch, and maintaining the teeth in their proper positions. These fibers serve to differentiate the histological characters of the gingivæ from those of the general gum tissue. The coarser fibrous mat from the gum tissue continues into the gingivæ, but becomes finer and more closely woven and is reduced in proportional amount. There is in the gingivæ a larger proportion of cellular elements and blood vessels, and the tissue seems softer. See Figure 1209, from the mouth of a child of 14 years.

THE GINGIVAL CREVICE.* This term was applied by Gottlieb to the space between the inner epithelial surface of the gingiva and the enamel, resulting from the detachment of the gingivæ from the enamel.

Gottlieb and his followers have stated that the tooth is not fully erupted when it is in full occlusion, for the reason that a part of the enamel is at that time covered with the gingivæ, also that the gingiva is attached to the enamel for some distance, usually the major part of the distance, from the cemental line to the crest of the gingiva. He does not consider the tooth to be fully erupted because, under the circumstances mentioned, all of the enamel of the crown is not bathed with saliva. He divides the eruption into four stages, full eruption being attained when the gingivæ is attached to the cementum only.

This conception is based on a new definition of the word eruption, which has been generally understood to be "the advancement of a tooth from its crypt through surrounding tissues to its normal position in the arch." Clinically it appears to make no difference whether one states that the gum recedes or the tooth continues to erupt. Either term expresses the gradual change which takes place in the relative positions of the gingivæ and the cemental line of the tooth.

Gottlieb further states in this connection that the major portion of the enamel epithelium remains attached to the enamel cuticle and the crevice between the unattached portion of the gingivæ and the enamel is normally very shallow. Orban† published a table of measurements of the depths of the gingival crevice on "microscopic specimens of human teeth." This showed "that 45% were less than 0.5 mm. deep; 29% between 0.5 and 1 mm. deep, 26% were deeper than 1 mm. The average crevice is about 0.8 mm. deep." No reference is made in this statement to the ages of persons from which the material was obtained.

There appears to be no correlation of clinical studies with laboratory measurements of specimens to which fixatives have been applied. It seemed desirable, therefore, that a study should be made of the conditions prevailing in the mouths of a considerable group of young persons.

CLINICAL STUDY OF THE GINGIVAL CREVICE.* This study was made to determine clinically the depth of the gingival crevice at different ages, in the mouths of young persons. The teeth chosen for measurement were the four permanent first molars and the four permanent central incisors. Only mouths with the soft tissues

* The term *gingival crevice* (crevice is defined as "a narrow opening resulting from the separation of a junction") is substituted for the term *subgingival space*, formerly used in this work, for the reason that it may be applied to whatever space exists between the gingiva and the enamel, as a result of the detachment of the gingival epithelium from the enamel, whether it extends to the cemental line or not. The *subgingival space* had come to be understood to apply only to a space extending fully to the cemental line.

† Dental Histology and Embryology, p. 117.

in apparently healthy condition were used. For each of the first molars, the depths of the crevice on the mesial and buccal surfaces were measured; for the incisors, only the labial crevice was measured. This made twelve measurements for each person. A total of 2880 measurements were made for 240 persons, divided into three age groups,— 5 to 12 years, 13 to 19 years, and 20 to 27 years. These measurements were considered adequate for this study.

The instruments used were the right and left periodontal membrane explorers. These were graduated in millimeters to facilitate the depth reading, and a very thin zinc collar, around the blade, was moved to make contact with the crest of the gingiva when the end of the blade reached the bottom of the crevice. In making the measurement the instrument was placed with the flat side against the tooth surface and parallel with the long axis of the tooth. It was passed very gently between the gingiva and the tooth. No hemorrhage resulted in any case and no evidence of irritation could be observed. The instruments in position in making the measurements are illustrated in the radiographic reproductions, Figures 1202, 1203 and 1204.



FIG. 1202.



FIG. 1203.



FIG. 1204.

FIGS. 1202, 1203 and 1204. Reproductions of radiographs illustrating technic in measuring depth of gingival crevice.

In making these measurements there could be no question of the existence of the crevice, as it was not possible to detect the least resistance to the most gentle manipulation of the instrument. So far as could be judged, the end of the instrument was passed approximately to the cemental line in practically all cases. It was of particular interest that several of the patients had partially erupted teeth, and the explorers could be passed between the gum flaps and the enamel without pressure.

The slightest depth of crevice recorded was 0.8 mm. on the labial surface of a lower central incisor.

The gradual recession of the crest of the gingivæ in relation to the line of the attachment is very clearly demonstrated by these figures. This indicates that two separate factors should be considered: the actual shortening of the gingivæ and the recession of the line of attachment.

* Report of a study by George W. Teuscher and Arne F. Romnes.

SUMMARY OF MEASUREMENTS OF DEPTH OF GINGIVAL CREVICE.

The average measurements are given in millimeters. Separate measurements were made on the buccal and mesial of each first molar, and on the labial of each incisor.

NO. OF PATIENTS	AGE	LOWER FIRST MOLARS				UPPER FIRST MOLARS			
		RIGHT		LEFT		RIGHT		LEFT	
		M	B	M	B	M	B	M	B
80	5-12	2.5	1.9	2.6	1.9	2.5	1.8	2.5	1.7
80	13-19	2.3	1.6	2.4	1.6	2.3	1.5	2.4	1.4
80	20-27	2.0	1.3	2.0	1.2	2.2	1.2	2.2	1.2

		LOWER CENTRAL		UPPER CENTRAL	
		INCISORS.		INCISORS.	
		R	L	R	L
80	5-12	1.3	1.3	2.3	2.3
80	13-19	1.2	1.2	1.7	1.7
80	20-27	1.1	1.1	1.2	1.2

In the author's experience in measuring the depth of the crevice on various sides of the teeth of many persons, which have been done in routine mouth examinations for more than twenty-five years, it has been the rule to record only depths in excess of 2 mm. on proximal surfaces and in excess of 1 mm. on labial, buccal and lingual surfaces, as representing possible detachments from the cementum. These measurements were for adults. Depths less than those mentioned have been recorded for elderly persons, particularly in cases in which the gingivæ had receded and the attachment was to the cementum.

GINGIVAL CREVICE IN FROZEN SPECIMEN. The two illustrations, Figures 1206 and 1207, were made from the same specimen from the jaw of a young dog. A large block including one tooth and its investing tissues was removed and frozen. Without allowing the block to thaw out the preparation was rapidly ground flat on both sides so as to prepare a section in the labio-lingual plane and about 2 mm. in thickness. The section was subsequently handled and photographed while immersed in water. A fine broach was very gently inserted between the gingiva and the enamel and the gingiva was thereby pushed away from the enamel. No appreciable force was required to separate the tissue as far as the cemental line, at which level the gingiva was so firmly attached to the tooth as to prevent its further detachment with the instrument used. The specimen was then photographed by reflected light (Leitz Ultrapak). C, Cemental line. G, Gingiva. E, Enamel. D, Dentin. B, Broach. GC, Gingival crevice.

The instrument was then removed. The gingiva fell back into place, lying so snugly against the enamel that there was no apparent crevice except at GC, less than one millimeter from the gingival crest.

ATTACHMENT TO ENAMEL NOT MAINTAINED. The above statements indicate that the attachment of the inner epithelium of the gingivæ to the enamel is not sufficiently secure to be maintained after the gingivæ have assumed their function of resisting the stresses brought upon them in mastication. Notwithstanding the fact that, in the majority of mouths of young adults, the gingivæ are detached from the enamel nearly or fully to the cemental line about the entire circumference of the tooth, they are held in very close adaptation to the enamel by the strong bands of fibers of the peridental membrane in all cases. Evidence of pressure contact is shown by the flattened scales of serumal calculus found attached to the surface of the enamel in cases in which there has been no disturbance of the attachment of the peridental membrane from the cementum.

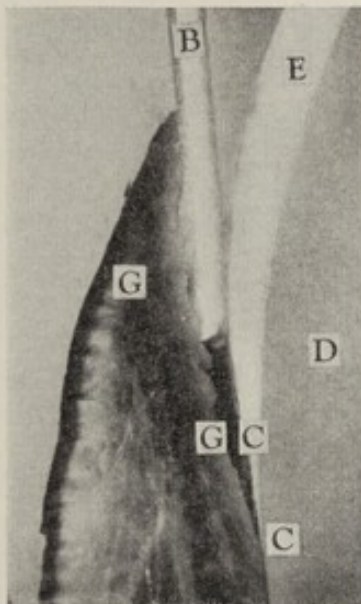


FIG. 1206.

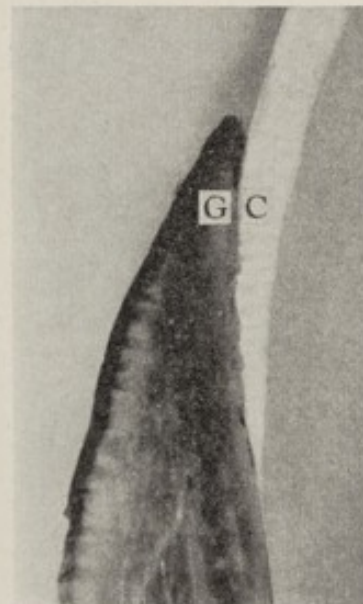


FIG. 1207.

FIGS. 1206 and 1207. Demonstrations of gingival crevice—young dog.

THE SEPTAL GINGIVÆ. The septal gingivæ are processes of soft tissue which under normal conditions fill each interproximal space to its contact point. At the angles of each of the teeth the septal tissue joins with the lingual and labial or buccal gingivæ by continuity and even fullness of form as the one passes imperceptibly into the other. The division between the two is a matter of form, and the naming of them separately is for convenience in description. But the difference in form is very real. Each septal gingiva fills a space between the proximal surfaces of two teeth. Each labial, buccal or lingual gingiva covers an otherwise free surface of the enamel. Each septal gingiva has two gingival crevices, a mesial and a distal; each labial, buccal or lingual gingiva has but one gingival crevice. There is a difference in the firmness and plasticity of the septal gingivæ as compared with the labial, buccal or lingual gingivæ. This tissue, being broader and thicker,

has within it much more of plastic tissue and is much more easily compressed. After a considerable compression, as by food impaction, it will again assume its normal form, provided the compression has not been too long maintained.

When normal and of good form, the septal gingivæ are more or less wedge shaped and fill the greater portion of the space between the teeth from the cemental line to the contact point. Figure 1208 is a mesio-distal section through the upper first and second bicuspid and the septal gingiva at the position of the contact point of the teeth, from the mouth of a boy ten years old. It fills the space completely to the point of contact. It has a very slight epithelial covering except at the crest. The occlusal edge or surface of the septal gingiva slopes away from the contact point buccally and lingually to the level of the buccal and lingual gingivæ. The open spaces on either side of the contact point, to the occlusal of the septal tissue, are called the buccal and lingual embrasures. It is through these that food, crushed between the teeth and divided

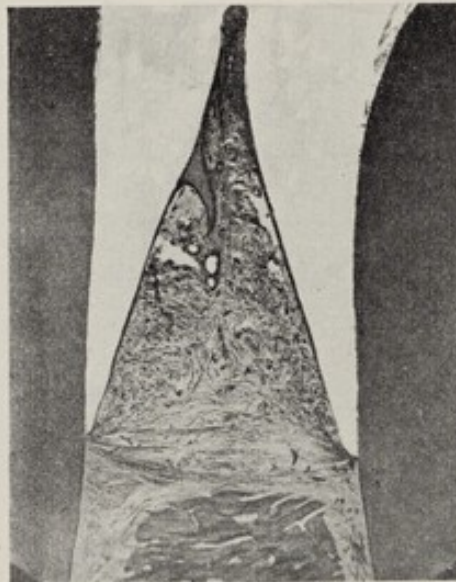


FIG. 1208. Mesio-distal section through septal gingiva of boy ten years old. *Kronfeld.*

by the contact points, glides upon the sloping surfaces of the septal gingivæ to either side of the arch. This sliding is facilitated by the widening of the embrasures to the buccal and lingual, by the slope of the surfaces of the septal gingivæ and by the lubrication by mucus.

The *form* of the surface of the septal gingiva which is exposed to the food which glides over it, is very similar to that of a letter V, with the point of the letter at the contact point, and the sides extending buccally and lingually. The angle formed by the two lines may approximate a right angle in the incisor and bicuspid regions, or may be an acute angle when the teeth have long bell-shaped crowns. Between thick-necked teeth, especially between the molars, it may be an obtuse angle, the slopes to either side being comparatively flat, yet there is sufficient slope to the buccal and

lingual, aided by the broadening of the open embrasures, for food separated by the contact to glide to the sides of the arch without difficulty.

At the point of contact, between any two teeth, the septal tissue is reduced to a very thin edge; this becomes thicker progressively toward the cemental line, to fill the space made by the greater separation of the surfaces of the teeth, so that in some of these spaces the tissue becomes a comparatively thick mass. In the buccal and lingual directions, the thickness of the tissue increases as the teeth round away from each other in forming the embrasures toward their buccal and lingual surfaces, until it meets evenly with the buccal and lingual gingivæ at the angles of the teeth. In this slope, between the teeth, the surface of the septal tissue is flat mesio-distally, and joins against the teeth in a right angle as it is reflected to form the surfaces of the gingival crevices to the mesial and distal sides of its substance.

EPITHELIUM OF THE GINGIVÆ.

The epithelial covering of the gingivæ is one of the very important elements of their histological structure. Immediately after passing the level of the crest of the bony alveolar process toward the crests of the gingivæ, the epithelial covering of the gum tissue becomes thicker and stronger, with the cellular elements themselves smaller and more closely disposed. As this epithelium becomes thicker, the interdigitation of the connective tissues beneath, into the epithelial covering, becomes longer, more closely set and finer. The connective tissue projections are reduced to fine strings, each of which includes a minute arteriole and returning vein with a rich little capillary circulation about them. These extend almost completely through this thick mass of epithelium for its growth and support.

If the superficial epithelial cells of the gingivæ are scraped away with a sharp instrument, blood will ooze out long before any considerable portion of the epithelium has been removed. The bleeding is the result of cutting the ends of the connective tissue prolongations into the body of the epithelium, which carry the blood for the support and quick repair of abrasions and cuts received in chewing coarse foods. If a careful examination of this scraped spot is made on the morrow, no trace of the injury will be found. Each of these minute ends of connective tissue, carrying these delicate blood vessels, has a complete clothing of young epithelial cells around it, ready to supply new cells for any such break which may occur.

This epithelium is continued, and these ends of connective tissue carry the blood supply to the thinnest part of the finest, apparently knife-edge of the crest of the gingivæ of the labial, buccal and lingual surfaces of the teeth. Then the epithelium is reflected over the thin margin and clothes also the portion of the soft tissue that is in contact with the enamel to the cemental line. The layer of epithelial cells is much thinner, and especially are they

much softer and less compact than those of the outer surface of the gingiva.

That portion of the surface of the septal gingivæ which is exposed to the friction of food is covered with epithelium which in all respects is similar in quality and thickness to that described as belonging to the gingivæ of the labial, buccal and lingual surfaces. The epithelium is reflected over its margin onto the tissue in contact with the enamel, mesial and distal, in the same manner and with a similar thin coating of a softer quality of epithelium.

In a large majority of cases, particularly in young persons, the epithelial lining of the gingivæ terminates at about the cemental line, as illustrated in Figures 1209 and 1210. Gottlieb has called attention to the fact that with advancing years, as the gingivæ be-



FIG. 1209.



FIG. 1210.

FIGS. 1209 and 1210. Sections of normal gingivæ, showing epithelial covering and projections of connective tissue into the epithelium, also the termination of the crevice epithelium at the cemental line.

come shorter, the epithelium proliferates along the root surface into the peridental membrane, with attachment to the cementum. In some cases, this also appears to occur as a result of inflammation of the gingiva, as illustrated in Figure 1211. When there occurs a recession of all of the investing tissues, with some exposure of the cementum, the epithelium will be attached to the cementum for at least a short distance at a point about 2 mm. from the crest of the gingivæ, and may be attached to the cementum to the full height of the gingivæ, as appears to be the case in Figure 1212. Clinically, there is usually much less of a crevice when the gingiva is in contact with the cementum, as compared with cases in which it is in contact with the enamel.

EXPLORATION OF THE GINGIVAL CREVICES. Disease of the peridental membranes often begins in the depths of the gingival crevices. Therefore, the exploration of these spaces is of first importance as a preparation for the early detection of diseases of this character. This exploration should be made with peridental explorers—a pair of thin, flat, slightly curved blades with rounded, dull edges. These instruments may be passed to the depth of the crevice without danger of injuring the attachment of the tissue to the tooth. See Figure 1492.

In the examination of a number of persons, ranging from eight to forty years, one will gain a correct idea of the changes which occur in the height of the gingivæ as age advances, which will be very useful, and can not be so well learned in any other



FIG. 1211.

FIG. 1211. Section showing downward growth of the epithelium of the gingival crevice, with attachment to the cementum.



FIG. 1212.

FIG. 1212. Section showing crevice epithelium, which is apparently attached to the cementum.

way. Experience in gingival examinations will enable one to detect the beginnings of disease by noting slight detachments of the peridental membrane.

In making a series of examinations, one will obtain much valuable information regarding the gingival crevices. It will be found that the distance from the incisal edge of the central incisor to the cemental line is much greater upon the labial surface than on the proximal surface, yet the gingivæ will be longest on the proximal surface. This is because of the form or direction of the cemental line around the incisor tooth. This line is curved upon the labial surface with the concavity toward the incisal edge of the tooth. It passes around the proximal surfaces in a curved line

which presents its convexity toward the incisal edge of the tooth. This form of the line of attachment, the cemental line, is common to the incisor teeth and the mesial surfaces of the cuspids, above and below. The distal surface of the cuspid usually has only a slight curve toward the incisal. On the bicuspid and molars the usual course is more nearly a straight line around the tooth. See Figures 1213 to 1222.

On some teeth the line of attachment has irregularities which one should be able to recognize. As the instrument is passed around the tooth feeling the attachment, it may come to a point where the attachment is higher on the crown. At this point the cementum may have lapped a little more than usual upon the enamel. On carefully lifting the end of the instrument onto this, it is often found to be of only slight extent and the instrument will again drop to the former level. On the other hand, the instrument may drop into a depression in the line around the tooth, at which the cementum has lapped the enamel less than elsewhere.

FUNCTIONS OF THE GINGIVÆ.

A PROTECTIVE TISSUE. The function of the gingivæ of first importance is that of a protective tissue. This is a passive function exerted through the form and solidity of their structure, as the soft tissues are closely adapted about all of the teeth, filling smoothly all interstices and shielding the tissues beneath.

The epithelial covering of the gingivæ protects the supporting structures of the teeth in much the same manner as the enamel protects the dentin and pulp. So long as the enamel remains intact, or is repaired by restorations before the dentin is much involved by caries, the vitality of the pulp and the integrity of the periapical tissues are preserved. Similarly, as the health of the gingivæ is maintained, disease of the peridental membrane and alveolar process is prevented. Thus chronic infections of the peridental structures are prevented by maintaining the integrity of the gingivæ, through close watchfulness and prompt attention to slight inflammations, just as chronic infections of the periapical tissues are prevented by frequent, careful examinations and prompt restorations of the enamel in the treatment of caries.

The hard tissues of the teeth become useless without their soft tissue investment. Their usefulness depends directly upon the strength and health of that investment. It is not enough that the gingivæ by the aid of the bony alveolar process hold the teeth firmly in their positions. Their forms about the teeth must be such as will shed off the débris of mastication and prevent all lodgments which in their decomposition would give rise to disease-producing compounds.

The outward form of the gingivæ in and of itself, is of the utmost importance. The maintenance of this is one of the first elements of good service in dentistry. Any deviation from the best form constitutes a barrier to the health of the teeth and

their investment—the gingivæ and the periodontal membranes.

MAINTENANCE OF THE TEETH IN THE LINE OF THE ARCH. A second function of the gingivæ is the maintenance of the teeth in the line of the arch. The influence of the bone forming the alveolar process has been much overrated in its importance in maintaining the teeth in their positions. Hard and rigid as the bones of the skeleton seem in the dried state, bone is a very plastic tissue during life, and is subject to more or less constant resorptive and rebuilding processes.



FIG. 1213.



FIG. 1214.



FIG. 1215.



FIG. 1216.



FIG. 1217.



FIG. 1218.



FIG. 1219.



FIG. 1220.



FIG. 1221.



FIG. 1222.

FIGS. 1213 to 1222. A selection of teeth to show their cemental lines. The curvature of the cemental line on the proximal surfaces of the incisors and cuspid may be compared with those of the bicuspid and molars.

The teeth may be drawn through the bone, where there is no possible chance for the bone to be bent away. The solid bone must be moved, or when it can not be moved in substance, it will be moved by resorption in one position, and building in, in the other. It will not stand against a connective tissue constancy of stress. The connective tissue group, other than active muscles, has a great function in directing the building of the body, holding organs in their

places in health, and bringing them back to place when the correction of conditions will allow them freedom of action. These, indeed, are the most active of the tissues in maintaining the phylogenetic play of forces in shaping, trimming, forming and maintaining the development of the body in its general ancestral forms, and yet with the finest sense of ontogenetic development, or the shaping of the individual in all of its parts. There is no place in the human body where there are as fine examples of this play at control of form by the non-muscular connective tissue as in the gingivæ, or so much harm from its influence when the conditions have given them a wrong direction. This will necessarily come into discussion often in pathological studies of the influence of the various tissues.

The Cementum

ILLUSTRATIONS: FIGURES 1223-1250.

The cementum covers the root portion of the tooth, enclosing the dentin, and usually slightly overlaps the gingival portion of the enamel. It contains more organic material than the dentin and is therefore softer. It is laid down in layers which are thin near the cemental line, and become gradually thicker toward and about the apices of the roots, also in the bifurcations between the roots

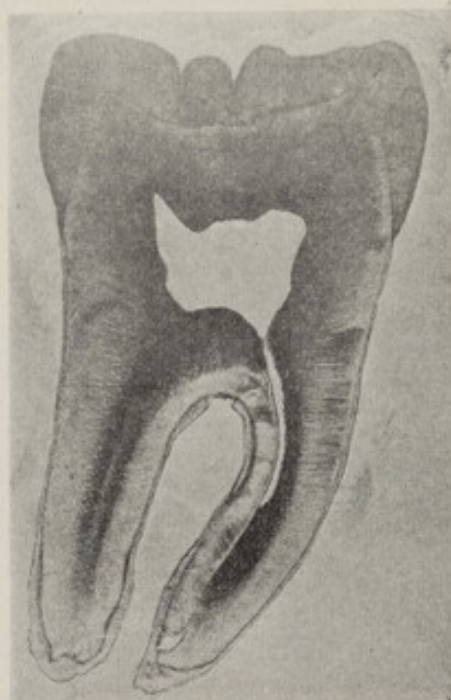


FIG. 1223. Section of a lower first molar. The cementum is thin near the cemental line and thick about the apices of the roots.

of multirooted teeth. See Figure 1223, a mesio-distal longitudinal section through a lower first molar. The cementum contains corpuscles—embedded cementoblasts, similar to those in bone, although they are less regularly placed and generally more widely scattered. The majority are located in the apical portion. See

Figure 1224, which shows cement corpuscles in the outer layers of the cementum, also Figure 1225, which shows two corpuscles, greatly magnified. Additional layers of cementum are deposited in response to the demands of use and, as it becomes thicker, the more deeply situated corpuscles gradually die. The corpuscles in the outer layers also die in regions in which the peridental membrane is detached from the surface of the cementum for a considerable period of time.

FUNCTION. One end of each of the principal fibers of the peridental membrane is embedded in the cementum, as illustrated in Figure 1224. The outer ends of all of the fibers, except those in the gingival region, are attached to the bone. The fibers nearest the cemental line turn occlusally into the gingivæ. Some fibers



FIG. 1224. Two fields of cementum showing penetrating fibers: GT, Granular layer of Tomes. C, Cementum not showing fibers, F, Penetrating fibers. Noyes.

pass occlusally of the crest of the interproximal septum of the alveolar bone, directly connecting the roots of the two teeth. The number of fibers embedded in the cementum is greatest in the region near the cemental line. It is therefore the function of the cementum to assist the peridental membrane and bone in holding the tooth in its proper position in the socket, also to give support to the gingivæ, by supplying anchorage for the fibers. In the physiological changes which are constantly occurring in the peridental membrane and bone, fibers of the peridental membrane often become detached from the cementum. These are reattached or new fibers become attached to the cementum as a result of the building of an additional layer of cementum by the cells within the peridental membrane and bone, fibers of the peridental membrane often throughout life; it has no reference to detachments which result from infection.

"The function of the cementum can not be too strongly emphasized, and must be continually borne in mind. If for any reason the tissues are detached from the root, they can only be reattached by the formation of a new layer of cementum on the surface of the root, which will embed the surrounding connective tissue fibers. In order to accomplish this, the tissues must lie in physiologic contact with surface of the root, and the connective tissue cells must be actively functional."*

SPECIALIZED TISSUE. The cementum is different from any other tissue in the animal body. It is in every respect a passive tissue. It does not originate any form of physiological activity. It does not build itself, nor repair injuries to its own tissue. It is laid



FIG. 1225. Section of cementum showing cementoblasts magnified $\pm 3000\times$. *Meyer's Histology; Churchill.*

down on the dentin by the peridental membrane very much as subperiosteal bone is built by the periosteum. It is much like bone; its corpuscles are similar to bone corpuscles, and it very closely resembles subperiosteal bone in its histological content. But the corpuscles are usually fewer and less regularly placed. In some specimens, however, the cement corpuscles are plentiful. In this, different specimens vary widely. The cementum is much thicker toward the apex of the root, and thins away toward the cemental line, lapping slightly on the margin of the enamel.

DIFFERENCES BETWEEN CEMENTUM AND BONE. The point in which cementum differs most widely from bone is in the absence of a blood vascular system. In bone every part of the tissue is within the sphere of the circulation of blood, and, without aid from adja-

* Noyes' Histology, p. 162.

cent tissues, is subject to resorption and perfect rebuilding of its own tissues at any time. It has this power within its own tissue. Also subperiosteal bone is cut away by resorption and rebuilt as Haversian bone, which has numerous channels conveying arteries, veins and nerves. Cementum has none of these channels. It has no circulation of blood in any form. It is therefore dependent upon the peridental membrane for the maintenance of the vitality of its cement corpuscles, and of the cementum itself.

CEMENTUM CAN NOT REPAIR INJURIES. The cementum has no power of self repair. When any portion of the cementum is cut off from its peridental attachment, that portion becomes a dead tissue. It has no power of initiating or carrying forward any process of repair, because, having no circulation of blood, it can neither participate in inflammation or reparative reaction.

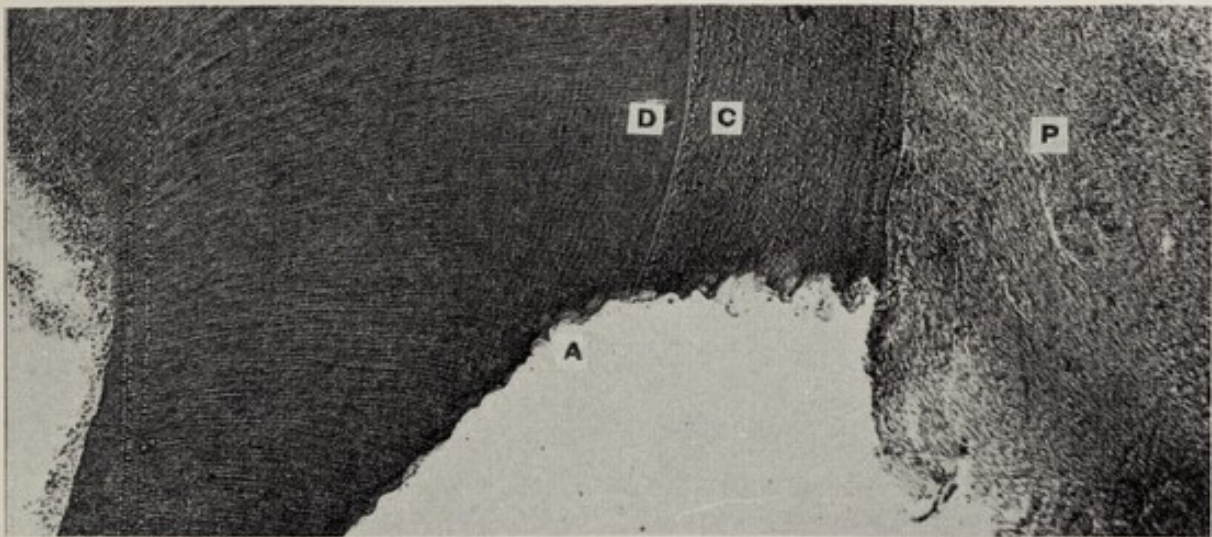


FIG. 1226. Resorption of a root.

CEMENTUM SUBJECT TO RESORPTION. The otherwise normal cementum is frequently subject to resorptions. These begin upon the outside, next to the peridental membrane, and extend inward or laterally from that beginning. This is the true physiological process as observed in the removal of the roots of the temporary teeth. During the resorption of the roots of the temporary teeth, it often occurs that a beginning resorption is repaired by the deposit of new cementum by the cementoblasts of the peridental membrane, filling up the breach made, either partially or completely. These repairs often occur after the resorption has penetrated the dentin to considerable depths. No matter what the depth of the resorption in dentin, the repair of the whole depth is always made by a deposit of cementum, never by building in dentin. There is nothing like an inflammatory disturbance in the cementum in connection with these resorptions. They are effected by the cementoclasts or by lysis. They do not differ materially from resorptions elsewhere in the body, as in the bones.

Figure 1226 is a transverse section of a tooth in which resorption was active and had penetrated deeply into the dentin—almost to the pulp. The region of resorption is marked A, the dentin D, the cementum C and the peridental membrane P.

Figure 1227 shows a repair of a much less extensive resorption, although it had penetrated the dentin to some depth. The secondary cementum as in many cases, has been built beyond the normal contour of the root. The normal cementum is indicated by C, the dentin D, the repair, consisting of secondary cementum R, and the peridental membrane P.



FIG. 1227. Resorption of root repaired with cementum.

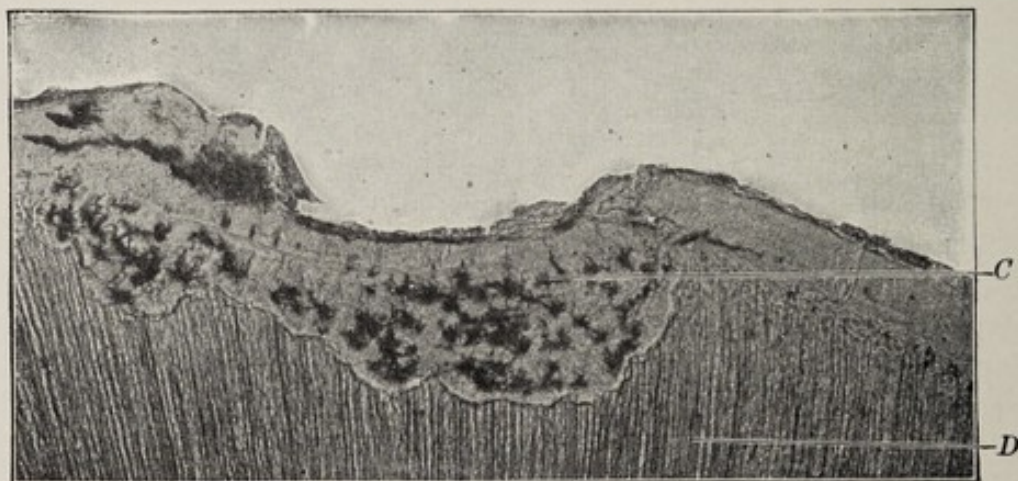


FIG. 1228. Record in the calcified tissue of an absorption repaired. *Noyes*.

A higher magnification of a repaired resorption is shown in Figure 1228. The dentin is marked D, and the secondary cementum C.

LOCALIZED RESORPTIONS OF ROOTS OF PERMANENT TEETH. Resorptions of portions of the cementum, often penetrating into the dentin also, occasionally occur in the roots of the permanent teeth. In part, this may be regarded as normal. In the movements of the teeth which occur, for instance, because of the loss of one of their number, the fibers of the peridental membrane are sometimes cut

away over a space, and a part or the full thickness of the cementum is removed, and possibly some part of the dentin also. When the movement of the tooth has been accommodated, the space will again be covered with new cementum, into which the principal fibers of the periodontal membrane will be attached. This can not be regarded as pathological. In the majority of cases these movements are accommodated by changes in the alveolar walls.

Similar changes occur in connection with the movements of teeth with orthodontic appliances. As slight pressure is applied to move a tooth in a certain direction, resorptions and rebuildings of both bone and cementum occur and the fibers of the periodontal membrane are loosened and reattached by the building of new bone and additional deposits of cementum. In cases of excessive occlusal



FIG. 1230.

FIG. 1230. Resorption of root of upper central incisor.



FIG. 1231.

FIG. 1231. Resorption of distal root of lower first molar.



FIG. 1232.

FIG. 1232. Resorption of roots of four upper incisors.



FIG. 1233.

FIG. 1233. Resorption of root of upper central incisor.

stress, the same changes may occur. As a rule, these resorptions and rebuildings cause no symptoms whatever.

A pathological resorption of the roots of the permanent teeth is of rare occurrence. Cases have been occasionally reported in which practically all of the teeth of the persons were lost in middle life from resorption of their roots. In these cases there were no other symptoms than the loosening of the teeth.

Figure 1230 shows a case of resorption of most of the root of an upper central incisor, the pulp of which remained vital, as do the pulps of the temporary teeth during root resorption. This tooth gradually became so loose that it was removed with the fingers.

Figure 1231 illustrates a resorption of the distal root of a lower first molar, in which it appears that the pulp was vital, notwithstanding the extensive restorations and the decay at the gingival margin of the distal restoration. A history of this case was not available.

Figure 1232 shows the four upper incisors from a mouth in which the roots of all of the teeth were being gradually resorbed in the manner illustrated. The patient, a woman of about 35 years, experienced no discomfort, but noticed that certain teeth were slightly loose. Eventually she lost all of her teeth.

Figure 1233 shows a resorptive process which involved the sides of the root and not the apex. While the broadest and deepest region is on the distal side, there are a number of other resorptions

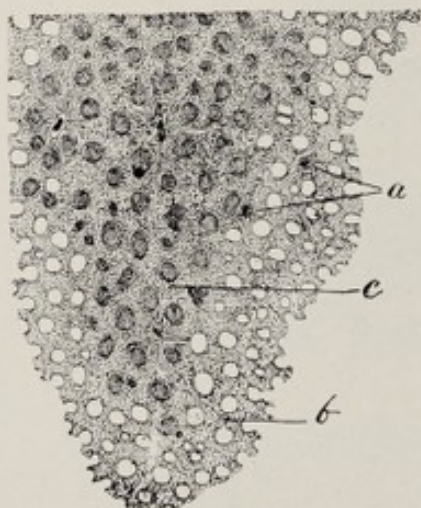


FIG. 1234.

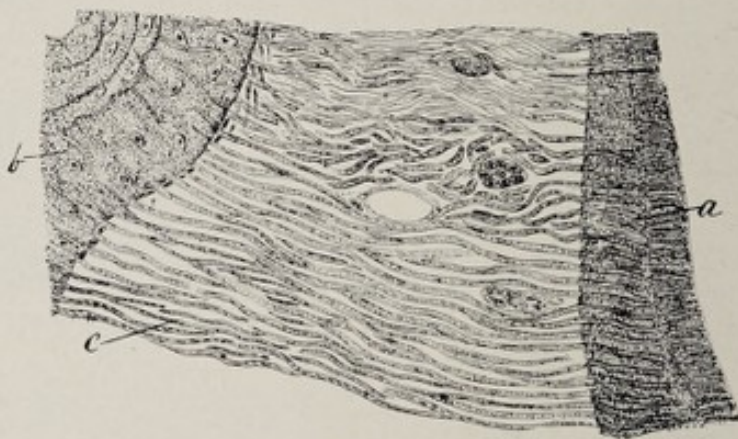


FIG. 1235.

FIG. 1234. Section of cementum of pig cut horizontal to and near the surface of the root of the tooth showing cross sections of the included fibers. A, cement corpuscles. B, holes from which fibers have fallen out. C, cross sections of fibers.

FIG. 1235. Fibers of the peridental membrane passing from the cementum a, to the alveolar wall b. Portion of a strong band of solid fibers c, which pass from the cementum to the bone.

about the root at the same level. When this type of resorption reaches the pulp it may cause severe pain.

ATTACHMENT OF PRINCIPAL FIBERS OF THE PERIDENTAL MEMBRANE TO THE CEMENTUM. The principal fibers of the peridental membrane, which secure the tooth in position, are attached to the cementum by being built around their ends with cementum, and by the calcification of their ends while the cementum is being laid down. This is accomplished by the cementoblasts, which furnish the calcifying ground substance for the cementum, just as the osteoblasts form the ground substance for bone. See Figures 1224, also 1234 and 1235. In many cases regions may be easily found from which the fibers have been cut away by resorption, and later reattached in a new layer of cementum.

CEMENTUM CONTINUOUS GROWING. The cementum is in a sense a continuous growing tissue. It is always thin on the roots of the

child's teeth and becomes thicker as the person grows older; often it becomes very thick in old age, particularly in certain regions. It is deposited in layers which are similar to the layers of subperiosteal bone, but in the building of cementum these layers are deposited one upon the other, always increasing the thickness of cementum as they are laid down. Each layer represents a new deposit of calcific material. A large number of layers may be counted in sections of the roots of teeth of elderly persons, but not so many in the teeth of young persons.



FIG. 1239. Hypertrophy of the cementum on the side of a root. a, Dentin. b, Cementum. c, Fibers of periodontal membrane. From b to c the cementum is normal, and the incremental lines fairly regular, but at d, one of the lamellae is greatly thickened. At e, this lamella is seen to be about equal in thickness with the others.



FIG. 1241.

FIG. 1241. An unusual case of hypercementosis; lower first bicuspid.



FIG. 1242.

FIG. 1242. Upper teeth with extensive hypercementosis.

HYPERCEMENTOSIS. Extraordinary growth of cementum appears frequently. In this condition the root ends are liable to grow larger and larger by deposits of cementum. Layer after layer may be found in some particular portion of the root, most frequently about the apex.

Figure 1239 illustrates a hypercementosis on the side of the root of a lower molar near the cemental line, which shows one exceptionally heavy layer. a, Dentin, b, Cementum, c, Fibers of periodontal membrane. At the right end of the illustration, from b to c, the layers of the cementum are of average thickness, while

at d, one lamella is greatly thickened, but thins down to normal at e. The next lamella is of exceptional width at g and h.

A very unusual case is shown in Figure 1241, a reproduction of a radiograph of a lower first bicuspid. This was the only tooth in the mouth which exhibited this condition. Figure 1242 is from a mouth in which there was hypercementosis about all of the roots similar to that shown in the upper bicuspid-molar region.



FIG. 1243.

FIG. 1244.

FIG. 1245.

FIG. 1246.

FIGS. 1243, 1244, 1245 and 1246. Roots showing extensive hypercementosis.



FIG. 1247.



FIG. 1248.

FIGS. 1247 and 1248. Teeth with roots fused by coalescence of cementum.

Figures 1243, 1244, 1245 and 1246 are photographs of three bicuspid roots with hypercementosis similar to that shown in Figure 1241, also one molar with a heavy development on each root.

When the roots of two teeth are lying closely together in the bone, they may be united by this extra deposit of cementum as illustrated in Figure 1247. Occasionally the roots of three teeth are fused in this way, as in Figure 1248.

Abnormal growths of cementum are occasionally found in the peridental membrane. These are called cementicles. Figure 1249 shows a cementicle attached to the cementum; Figure 1250 shows two cementicles free in the peridental membrane.

CEMENTUM IN ANIMALS. The cementum in the lower animals is similar in most respects to that of man. Physiologically there

seems to be no difference, although certain differences in form and thickness are observable. As a rule the cementum of the carnivora, as cats, dogs, etc., is rather thinner than in man.

In the omnivorous animals, and especially in the hog, the cementum is very thick and heavy and is generally well developed.

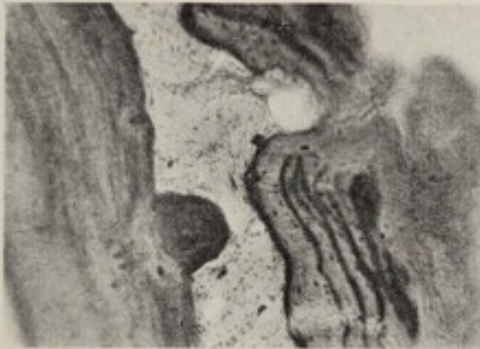


FIG. 1249.

FIG. 1249. Cementicle attached to cementum.



FIG. 1250.

FIG. 1250. Cementicles free in the periodontal membrane.

As seen in sections, its layers are well arranged, numerous, and the cement corpuscles are large, with as full a complement of fibrils as will be found in the bones. Yet in this splendid development of cementum there is no sign whatever of circulation of blood. For the best studies of these features the teeth of an adult animal should be used. See Figures 1234 and 1235.

In the strictly herbivorous animals the thickness of the cementum lies between these extremes and is more like that of man. There is no essential difference in the type of the tissue.

The Periodontal Membrane

ILLUSTRATIONS: FIGURES 1255-1273.

The term periodontal membrane* is applied to the soft tissue which is attached to the cementum of the entire surface of the root and extends to the bone of the alveolus, also the gum tissue and gingivæ. See Figure 1197. Its functions are: (1) to maintain the tooth in its proper position in the socket and in relation to its neighbors by its attachment (a) to the bone, (b) to the gum tissue to the occlusal of the bone and (c) to the cementum of the adjacent tooth; (2) to give support to the gingivæ and hold them in pressure contact about the gingival portion of the enamel (occasionally the cementum in later life); (3) to build cementum by which the membrane is attached to the root; (4) to build the bone of the alveolar

* As a matter of convenience in discussing the diseases and treatment which involve the periodontal structures, the word *periodontal*, or *pericemental*, is applied particularly to diseases beginning in the gingivæ, which involve the tissue progressively along the sides of the root, while the term *periapical* is used for conditions resulting from infections of the pulp.

wall for its attachment to the bone; (5) to supply the sensation of touch to the tooth.

Meyers* states that the average width of the space occupied by the peridental membrane, from the surface of the root to the alveolar bone is about 0.2 mm. at the mid-length of the root, and about 0.25 mm. near the apex, and about 0.35 mm. at the alveolar border. This is less than the diameter of the smallest hypodermic needle.

The peridental membrane is a very active tissue, having a rich vascular and lymphatic system and a rich supply of nerves. It is subject to inflammations and suppurations as these occur in other soft tissues. It is able to repair injuries to its own tissue, but does not rebuild its own tissue when any considerable part of this is detached from the cementum by suppuration. If the peridental membrane is cut from the tooth as closely as possible with a sharp lancet, as may readily be done in that part to the occlusal of the crest of the alveolar process, apparently perfect healing occurs very rapidly, provided there is no infection. The tendency of the tissue to come into apposition when cut, as has been mentioned, is a powerful influence for the prevention of infection in such cuts.

PRINCIPAL FIBERS OF THE PERIDENTAL MEMBRANE.

The peridental membrane has a special arrangement of fibers, called the *principal fibers*, the inner ends of which are embedded in the cementum of the root, while the outer ends are attached to the bone of the alveolus, to the cementum of proximal teeth, or are embedded in the gum tissue and gingivæ which surround the tooth to the occlusal of the alveolus. These fibers should be thought of as cords or guy wires to hold the tooth in place, but, instead of being straight, they are wavy, curving alternately this way and that as they are gathered into bundles, which in turn form groups. They resist or hold against movements of the tooth, yet may give a little as they are pulled more nearly straight, permitting the tooth to move, but their tension is increased with each further movement of the tooth. They consist of white connective tissue and are not elastic; therefore they can not be stretched. The tooth has a functional range of movement within its socket which represents the limit of straightening to which the fibers may be subjected without injury to the fibers or their attachment.

These fibers are generally arranged in groups or bundles. In many cases complete bundles of fibers can be traced from the cementum to the bone; many of them can not be so traced, as the fibers seem to split up into finer fibers and re-collect into bundles for insertion into the bone. This arrangement is maintained, with considerable variation, over the body of the root of the tooth.

The blood vessels, which pass from the position of the apex of the root, through the peridental membrane in the occlusal direction, lie almost centrally between the root and alveolar process

* Meyers' Histology, p. 113.

in young subjects. In many microscopic sections the vessels in the particular microscopic field displace the fibers so that their central portions are not visible; in other fields in the same section, the fibers may be followed from the cementum to the bone, even though they are very long. See Figures 1257 and 1267, in which both conditions are shown in different regions. In persons advanced in years, the blood vessels may be nearer to the bone of the alveolar process, or somewhat recessed in the bone.

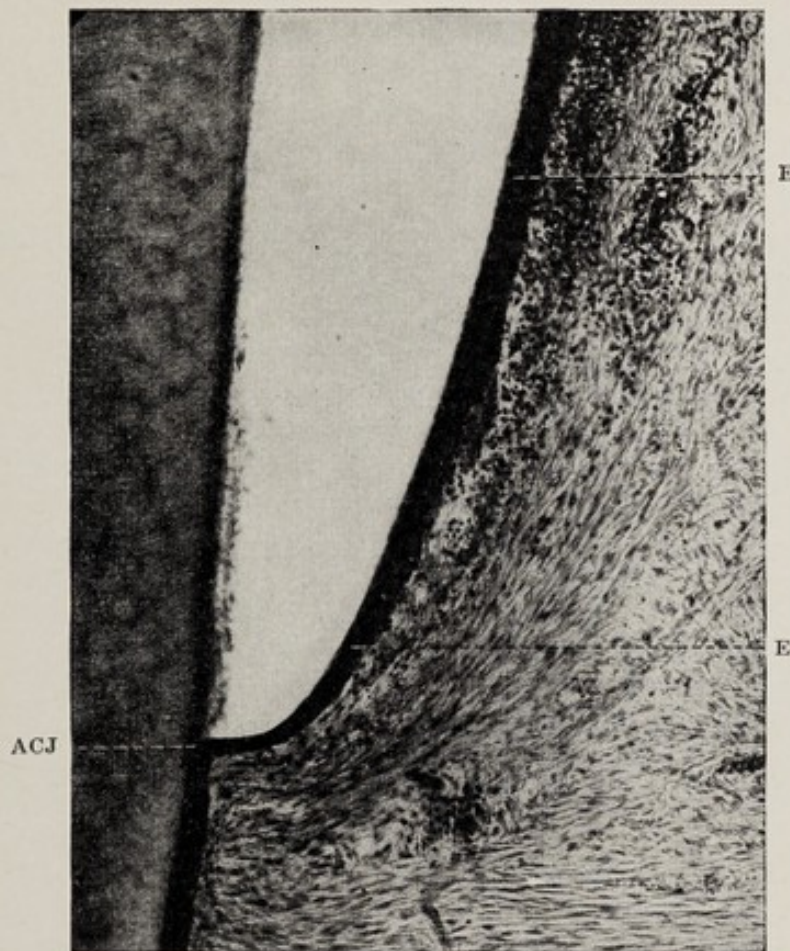


FIG. 1252. Normal gingiva showing gingival group of fibers of the periodontal membrane, also the epithelium of the gingival crevice, E, E, with its attachment at the amelo-cemental junction (cemental line), ACJ. *Meyer's Histology; Churchill.*

THE FUNCTIONS OF THE PRINCIPAL FIBERS are to swing the tooth in its socket, sustain it against the stresses of mastication, and support the gingivæ. However, an understanding of the conditions which result from the failure of any of the groups of fibers to function properly is quite as important as knowledge of their functions. Fiber groups extend in certain directions from the cementum, in order that they may best perform their physical function of holding the teeth and the surrounding bony and soft tissues in their proper relations. The several groups of fibers and their special functions will be separately described. Altogether this is a very beautiful mechanism adapted to support the tooth

and sustain forces brought against it in varying degrees and from several directions. Provision is made for each tooth to move slightly, as force is brought against it in any direction, in order that there may be no shock from the impact. The tension of the fibers sustains the tooth in its position in order that it may perform its function in mastication. As will be noted from the illustrations, several or many groups of fibers attached in various positions about the root, may be on tension in response to a single thrust of an opposing tooth.

Noyes has called attention to the fact that "the connective tissues are formed in response to mechanical conditions and stimuli, and therefore this arrangement must be considered, not as having been designed to sustain the force, but as being the result of the forces to be sustained, and therefore beautifully adapted to them."

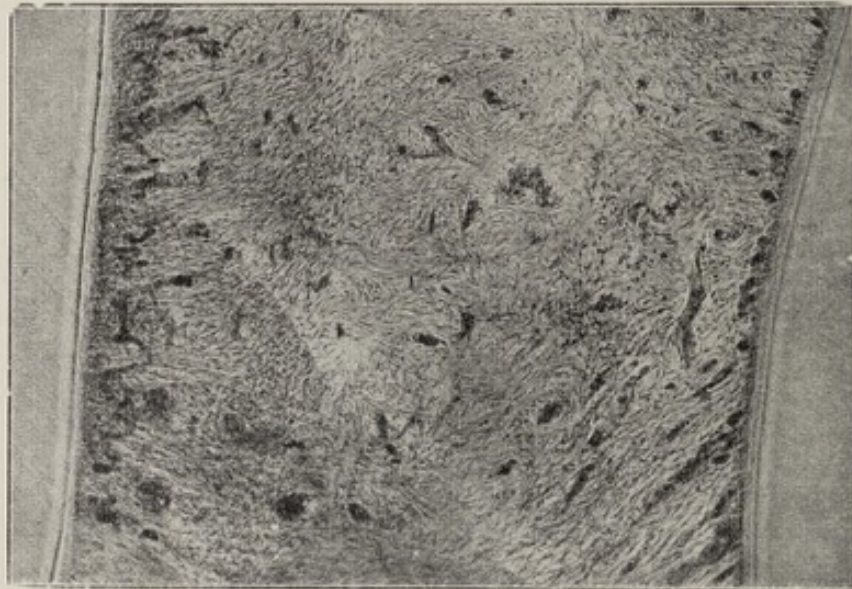


FIG. 1255. A portion of the periodontal membrane between two incisors of a young sheep, showing the trans-septal fibers extending from tooth to tooth. *Noyes.*

It may be added also that this adaptation applies to the strength of the forces as well as their direction, which is expressed in the development of muscles and other tissues as a result of exercise. The continued health of these important mouth tissues is largely dependent upon their vigorous use in mastication.

GINGIVAL GROUP. The fibers of this group extend outward for a short distance from the cementum, and then turn occlusally and are distributed to the gingivæ, where they unite with the fibrous mat which supports the epithelium. This group of fibers encircles the tooth completely, but is much thicker and stronger on the labial, or buccal, and lingual than on the proximal surfaces, and particularly strong on the lingual side, where the greatest pressure of food comes in mastication. As seen in longitudinal labio-lingual (or bucco-lingual) sections cut through the tooth and its investing tissues, it is a small, rather thick band of fibers, but if the entire

circumference of the tooth is considered, the fibers of this group make up quite a mass of tissue, contributing to the rigidity of the gingivæ. Due to the fact that these fibers are very intricately interwoven, they exert a circumferential pressure similar to that of a rubber band about the crown of the tooth.

Function. The function of this group of fibers is to hold the gingivæ snugly against the enamel, so that they may resist the pressures and movements of foods in the process of mastication. In this, the lubrication of the gingivæ with mucus is an important factor. Infection or injury which results in a very shallow pocket, even though it be confined to one surface of a tooth, will lessen the pressure contact of that gingiva, and establish a condition which may invite further injury and infection. See Figure 1252.

TRANS-SEPTAL GROUP. The fibers of this group arise from the proximal surfaces of the gingival portion of the roots of the teeth, and pass across and through the septal gingivæ to the occlusal of the bony septum from tooth to tooth, and from tooth to tooth, recurring in each interproximal space, attaching the teeth together continuously from one third molar around the arch to the third molar of the opposite side, in the upper and lower arches respectively. In many instances this group of fibers is composed of a number of bands which pass irregularly across from tooth to tooth. These are sometimes intermingled in a plaited or interwoven form. In histological sections which are cut horizontally through two or more teeth and their investing soft tissues, beginning with the crests of the gingivæ and continuing rootwise as the sectioning proceeds, this group of fibers connecting the teeth always consists of a large number of strong fibers. See Figures 1255 and 1322.

Function. This group of fibers has for its primary function the maintenance of the teeth in close contact. It will be quite apparent that it is aided in doing this by both the alveolar crest and horizontal groups, which are attached to the crest, and on either side near the crest, of the bone of the process, throughout its full width from buccal to lingual. Attention is again called to the fact that the cemental line is convex toward the incisal on the proximal surfaces of the incisors and cuspids, thus affording space for the attachment of many additional fibers of these groups to compensate for the lesser diameter of these teeth labio-lingually, also for the lesser width of the interproximal spaces between these teeth, as compared with the bicuspid and molars. See Figures 1213 to 1222.

The trans-septal group of fibers serves to hold the teeth together around each arch from one third molar to the other. The rigidity of the arches and the health of the supporting structures of the teeth depend to greater degree on the maintenance of this tooth to tooth relationship, with all the contacts tight, than any other single factor.

A detachment of slight depth (about 2 mm. on the average)

on the proximal surface of any of these teeth will cut off the attachment of the trans-septal fibers and the contact may be weakened by the unbalanced support of the fibers on the opposite sides of both teeth. When the trans-septal fibers are detached, the alveolar crest and horizontal groups may be sufficiently strong, or may become heavier to compensate for the loss of the trans-septal group, and a tight contact is maintained. However, when all three of these groups are destroyed by a detachment of 3 mm., or a little more, the possibility of maintaining a tight contact is greatly reduced. When the periodontal membrane is detached from one or both of the approximating teeth very gradually, and the resorption of the interproximal bone is correspondingly slow, changes may occur by which, apparently, the oblique fibers from the two roots become united and pass directly from one root to the other, immediately above the crest of the bone. They thus assume, as best they can, the function of the trans-septal group. A good example is shown in Figure 1478.

ALVEOLAR CREST GROUP. The fibers of this group pass out from the cementum and are inclined apically to their insertion into the crest of the alveolar process. They appear to best advantage in longitudinal labio-lingual (or bucco-lingual) sections. The periosteum covering the alveolar walls often extends over the curve of the crest of the alveolar process and a short distance on the labial, or buccal, and lingual surface, to give place for the attachment of the fibers of this group. This group forms a strong band completely encircling the tooth. It is, however, much stronger in its labial and buccal, or lingual, than in its proximal portions. See Figures 1257 and 1258.

Functions. The principal function of the fibers of this group appears to be that of assisting the horizontal group in resisting stresses applied more or less laterally to the long axis of the tooth, in which the apical group of fibers also participate. As already mentioned, the fibers of the alveolar crest group also join with those of the horizontal group to assist the trans-septal group in maintaining tight contacts. They have another function, in which fibers of the apical group and possibly others join, namely; to hold the tooth against movement occlusally, as in cases of apical pericementitis.

When both the gingival and alveolar crest groups of fibers are detached on the labial, buccal or lingual sides of the root, the gingiva loses its close adaptation to the enamel in that position, and is likely to be slightly inflamed as a result of the movements of food in chewing. The situation is also one which invites infection, particularly of the epithelium which lines the gingival crevice. In addition all of the strain of holding the tooth against lateral stress in the opposite direction is placed on the horizontal group of fibers, which may or may not multiply or increase in strength sufficiently to prevent a change in the position of the tooth.

HORIZONTAL GROUP. The fibers of this group are placed close

to the crest of the bony alveolar process and pass directly from the cementum to the bone and are attached to it, completely encircling the tooth. This is not a broad band of fibers, although it varies considerably in different specimens. Sometimes, in the incisor, cuspid and bicuspid regions, this band of fibers is about as broad as one-half the thickness of the root. The fibers are comparatively short, but very strong. The demarcation between this group of fibers and the alveolar crest group is not at all definite. See Figures 1258, also 1197.

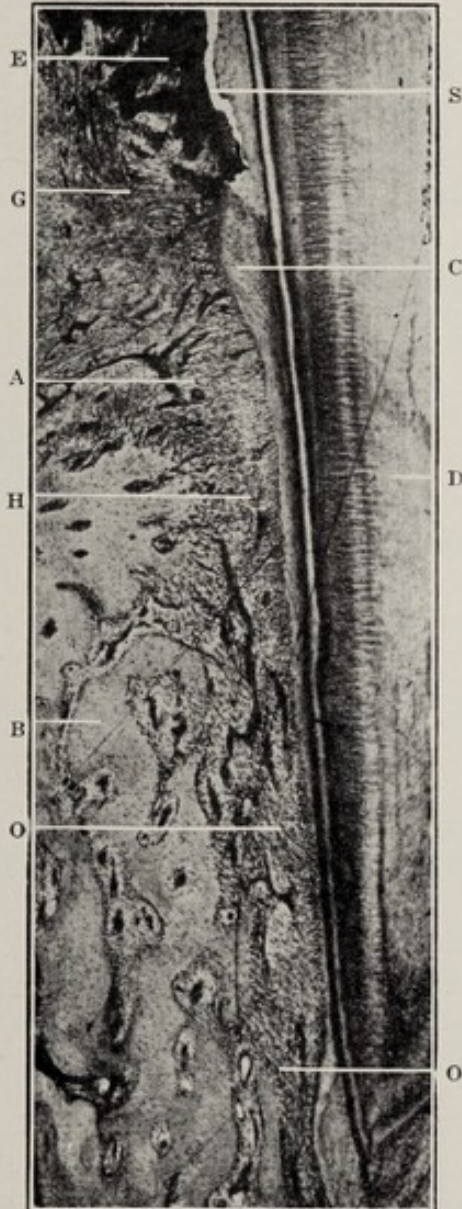


FIG. 1257.



FIG. 1258.

FIG. 1257. Longitudinal section, slightly oblique, through root and peridental membrane, showing fibers of the peridental membrane. E, Epithelium. D, Dentin. C, Cementum. S, The gingival crevice. G, Gingival group of fibers. A, Alveolar crest group of fibers. H, Horizontal group of fibers. O, O, Oblique group of fibers. B, Bone of alveolar process.

FIG. 1258. A higher magnification of a part of Figure 1257.

Functions. It is the particular function of the horizontal group to sustain the tooth against sudden lateral pressure, which

may occur in the chewing of food. It is, therefore, a very important group of fibers. This group is very materially assisted in sustaining the tooth against lateral pressure by the alveolar crest group and also by those fibers of the apical group which pass in the horizontal direction, and tend to prevent lateral motion of the apex of the root. As has been mentioned, the horizontal group assists the trans-septal group in maintaining the contacts of the teeth.

When a detachment of the fibers on the labial, buccal or lingual surface forms a pocket sufficiently deep to cut off this group of fibers, the sagging of the gingivæ is likely to be considerable, because there will also occur resorption of the bone of the crest of the alveolar process. The crown of the tooth will tend to move in the direction away from the detachment, due to the unbalanced support of the circumferential fibers about the root in this region. Infections, constant or recurrent, are also more likely.

OBLIQUE GROUP. The fibers of this group constitute the body of the peridental membrane. Just apically of the horizontal group there is a rather sudden change in the direction of fibers. They pass across in an oblique direction occlusally from the cementum to the bone. These fibers vary much in their length and some are much more oblique than others. They are gathered into bundles, more or less; some of the bundles are short, passing almost directly across, while others are long, passing quite a distance occlusally within the peridental membrane before they reach the bone. See Figures 1257 and 1197.

This description applies to the peridental membrane in a young person or young animal. As the person or animal grows older, and, particularly, when the teeth have been subjected to very severe use, the distance from the cementum to the bone will become very much less, and the blood vessels will come to lie in grooves in the alveolar process, so that the spaces between the blood vessels are filled with the fibers of the peridental membrane throughout this body portion of the bone. Such teeth are unusually firm in their sockets and will bear great pressure without injury.

Function. The fibers of this group swing the tooth in its socket and resist stress brought in the direction of the long axis of the tooth. These fibers perform the same function as a shock absorber on an automobile. The main bundles are at an oblique angle in relation to the long axis of the root, and offer no resistance to stresses which would tend to move the tooth laterally or cause rotation. However, there are many lesser bundles in all positions throughout the length of the root which are of some assistance in resisting both movements.

APICAL GROUP. The fibers of this group spread around the immediate apex of the root. They are attached to the cementum, in considerable bundles, which separate into smaller bundles. The general arrangement is in the form of cones as they spread out to their positions of insertion into the bone. In many cases these

bundles vary from a true cone-like arrangement to that of a flattened cone, producing a very considerable irregularity in the crossing of the bundles one over the other to reach the bone. See Figure 1197.

As the oblique fibers approach the apical region, they change their direction and pass more and more nearly horizontally to the bone. Eventually there is in effect an apical horizontal band of fibers encircling the root, made up of those oblique fibers which are very nearly horizontal and a considerable number of fibers of the apical group which pass outward horizontally or nearly so.

The bundle formation of the apical fibers gives space to a considerable indefinite connective tissue, which is the seat of the inflammatory condition in the beginning of alveolar abscess.

Function. The apical fiber groups are designed to hold the apex of the root centrally in its socket. These fibers perform this function with the assistance of the fibers of the oblique group which become very nearly horizontal as they approach the apex. The apical fibers assist the alveolar crest and horizontal groups in holding the crown against lateral stress.

If the apical groups are destroyed by a chronic periapical abscess, the crown has more lateral movement than before, since the attachment of the alveolar crest and horizontal groups then serve only as a fulcrum, on which the crown may move buccally while the root apex moves lingually, and the reverse. Therefore, under normal conditions, when stress is applied on the lingual inclined plane of the buccal cusp of a bicuspid, thus pressing the tooth buccally, the alveolar crest and horizontal fibers on the lingual side become tense, as do also the apical fibers on the buccal side. The reverse is true if the stress is on the buccal inclined plane of the lingual cusp.

RESISTANCE AGAINST ROTATION. There is also provision against stresses which tend to rotate a tooth. At any level from the cemental line to the apex, bundles of fibers pass from the root to the bone in directions which offer resistance to stresses which would tend to rotate the tooth. In doing so, fibers attached in several positions about the circumference of the root are brought into play, possibly throughout the entire length of the root. See Figure 1260.

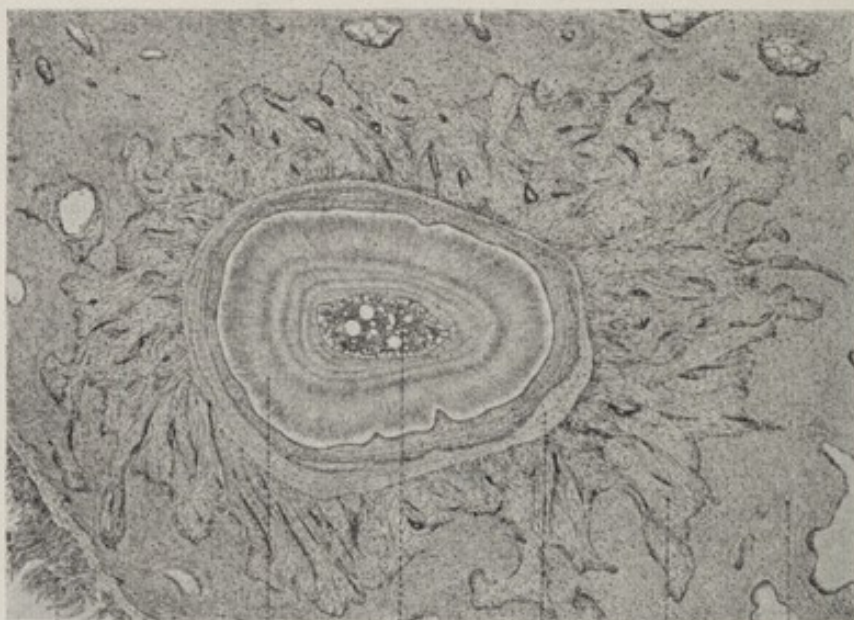
A clear understanding of the mechanical problems here reviewed is essential to an understanding of the pathology of practically all of the diseased conditions which involve the supporting structures of the teeth. These will be discussed in presenting the pathology and treatment.

STRENGTH OF THE PRINCIPAL FIBERS. The fibers of the peridental membrane, about many molar roots, are sufficiently strong to maintain the tooth against three hundred or more pounds of pressure, which gives an appreciation of their combined strength in supporting the teeth. Bicuspid and molar teeth which are un-

able to sustain a stress of a hundred pounds or more can not be used vigorously in chewing food.

The strength of the bite and the force required to chew various foods are discussed in Volume I, beginning with page 208.

THE INDEFINITE CONNECTIVE TISSUE. There is in the peridental membrane, mixed through among the principal fibers, a considerable amount of indefinite connective tissue, forming fibers which usually run somewhat nearly parallel with the length of the tooth, and yet there are a good many exceptions to this rule. They may take almost any course. These are attached to connective tissue cells and they are processes from these cells rather than true fibers. This connective tissue is largely the supporting tissue of the blood vessels, lymphatics, nerves, veins, etc., which pass to and fro in the peridental membrane. It fills up all the interstices between the bundles of the principal fibers. This tissue often disappears almost entirely in old subjects.



M Per D P Cm Pd Al

FIG. 1260. Diagram of peridental membrane. M, muscle fibers; per, periosteum; D, dentin; P, pulp; Cm, cementum; Pd, peridental membrane fibers; Al, bone of alveolar process. *Noyes*.

BLOOD VESSELS. The blood vessels are usually seen as coming into the peridental membrane in the apical space, and splitting up there and running parallel with the length of the tooth to the crest of the alveolus around the tooth, and there connecting with the blood vessels from the gums and the gingivæ. These blood vessels break up into more or less arterial and capillary groupings, as they pass through the peridental membrane. The number of these varies greatly. Other vessels pass from the gum over the crest of the alveolar process and enter the peridental membrane from that direction. Many vessels enter and pass out from the peridental membrane all about the body of the root through the alveolar process in quite plentiful numbers, passing through the Haversian canals into the bone and splitting up, more or less,

while passing through the bone, giving the bone of the alveolar process a very rich supply of blood, as well as a rich collateral circulation for the peridental membrane. In Figure 1257 a large blood vessel may be seen arching over the crest of the alveolar process either into or away from the peridental membrane, and a number are shown running parallel to the long axis of the root. The three sources from which blood vessels enter the peridental membrane are indicated in Figure 1197.

Practically all of the larger blood vessels within the peridental membrane run parallel to the long axis of the root. In horizontal sections from eight to twelve groups of blood vessels, nerve bundles and lymphatics may be noted, all of which are cut transversely. See Figure 1265, a horizontal section in which a number of blood vessel groups are cut transversely. The cementum is at the lower edge of the illustration. This generally lengthwise direction of the vessels becomes of unusual importance in studying the progress of infection along the sides of the roots.

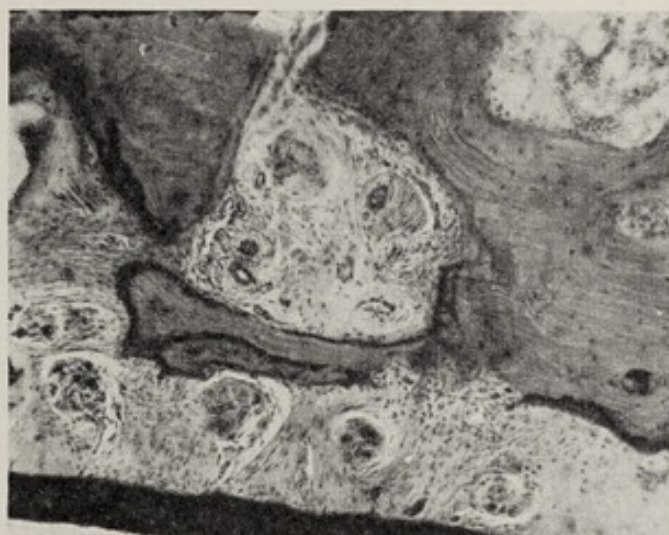


FIG. 1265. Horizontal section through peridental membrane and adjacent tissues, showing several blood vessel groups cut transversely. *Noyes*.

NERVES. The nerves of the peridental membrane follow the same course as the blood supply, and usually lie in close association with the blood vessels. The nerves also pass through the Haversian canals. A tooth does not lose its blood supply, nor its nerve supply, if the whole of the gingivæ is cut away to the crest of its alveolar process, nor if the whole of the apical space is cleared of tissue at the same time. The collateral circulation through the bone itself is always sufficient to maintain its vitality, and the nerve supply similarly received is sufficient to maintain its sensations. The sense of touch will remain unimpaired, and the sense of pain, in cases of inflammation of the membrane, will be the same as if the peridental membrane were perfect in all of its parts.

The sense of touch of the tooth resides in the peridental membrane, the slightest touch being registered as such on the sensorium. It will be seen then, that while the peridental membrane is

the organ of touch for the root, this sense of touch is not disturbed by the destruction or removal of the tissues from the gingival end of the membrane, or those from the apical end of the root, or by the loss of the tissues from both positions at the same time. The nerve fibers can be identified along with the blood vessels in Figures 1267 and 1268.

LYMPHATICS. Attached to the walls of the blood vessels and nerves are chains of lymphatics. These were demonstrated by Dr. F. B. Noyes and were first reported* by him in 1918. They are of great importance in a study of the progress of infections, as they form a route of transmission from the gingivæ to the deeper structures. The blood vessels, lymphatics and nerves of the peridental membrane are generally about midway between the surface of the root and the bone, running parallel to the long axis of the root, and since the minute lymphatics attached to the walls of the

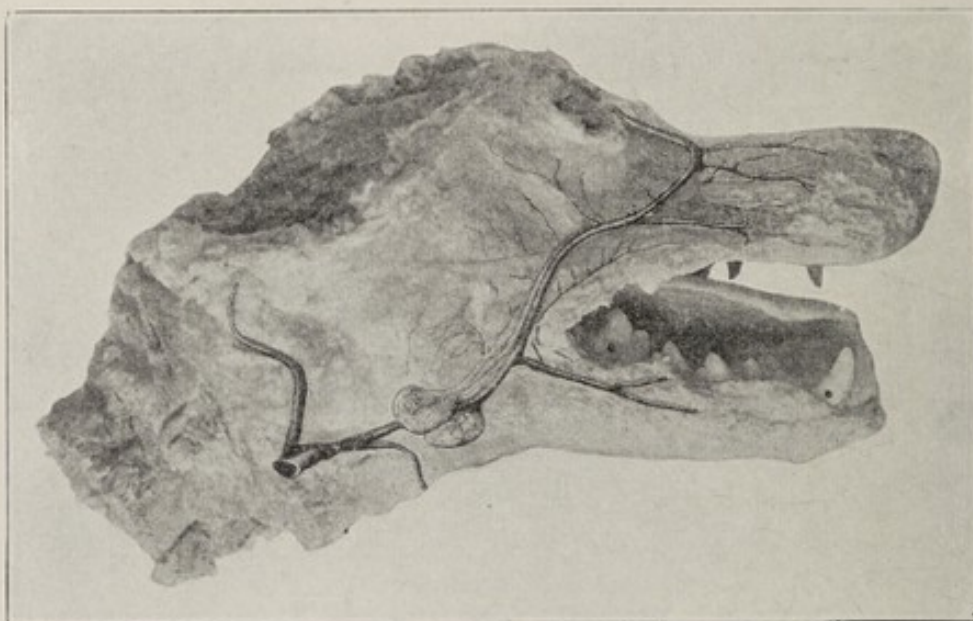


FIG. 1266. Dog's head showing injected lymph vessels from the infra-orbital and mental foramina to the submaxillary lymph nodes. Noyes.

vessels are carriers of infection, it seems quite clear that the initial involvement of the peridental membrane is along the routes of the vessels. Clinically, pockets generally progress in depth, toward the apex of the root, more rapidly than in width, around the root. This clinical observation is explained by the fact that the vessels, with the attached lymphatics, run parallel to the length of the root, and the movement of the lymph is toward the apex.

Figure 1266 is from a photograph of the partially dissected head of one of the dogs used in Noyes' experiments. The facial artery is shown, also the accompanying lymphatic trunks which drain the upper and lower dental regions to the cervical glands. Holes were drilled into the pulp chambers of the canine and first

* Jnl. Amer. Med. Assn., Vol. 71, p. 1179. Noyes' Histology, Fourth Edition, p. 191.

molar in order that injections might be made into the pulp; other injections were made into the gingivæ near their margins. Without giving the details, it may be said that injected colored fluid made it possible to trace the lymphatics accompanying the blood vessels through the pulp and the peridental membrane, also through the mandibular and infraorbital canals, to the cervical lymphatic glands.

Figure 1267 shows a horizontal section through the peridental membrane in which the fibers are beautifully shown, also several blood vessel, nerve and lymphatic groups. The darker stained tissues in these groups are the lymphatics. Figure 1268 shows a single group with a larger proportion of lymphatic tissue. It will be noticed that this group occupies almost the full width of the peridental membrane from the bone to the cementum. In both illustrations the curving of the fibers of the peridental membrane to make room for the vessel groups is very nicely shown.



FIG. 1267.

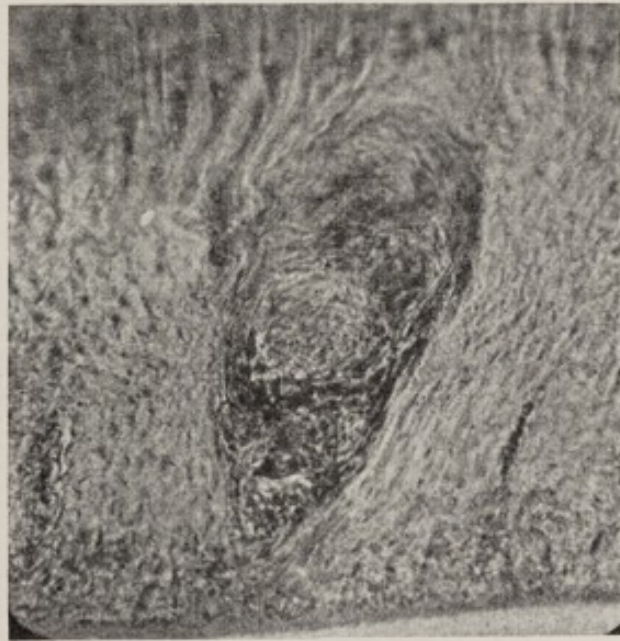


FIG. 1268.

FIGS. 1267 and 1268. Horizontal sections of peridental membrane showing groups of blood-vessels, nerves and lymphatics. The lymphatic tissue is stained darker than the blood vessels or nerves.

OSTEOBLASTS. The osteoblasts of the peridental membrane are in no wise different from the osteoblasts of other bone regions in the body. They lie upon the bone of the inner surface of the alveolar process the same as upon the surface of other bone. They almost completely line that surface of the bone next to the peridental membrane, leaving only room for the attachment of the fibers of the peridental membrane, which pass between them. In Figure 1269, the fibers of the peridental membrane which penetrate the bone are marked Pd M, the osteoblasts ob¹, osteoblasts in the medullary space ob², subperiosteal bone Pb B, a medullary

space MS, and Haversian system bone built around the medullary space HB.

Whenever the fibers of the peridental membrane lose their attachment to the bone, whether it be by resorption of the bone or otherwise, these cells build on more bone about the fibers and the fiber ends calcify with this bone and are thus reattached to the bony wall. This function occurs in any case where the tooth is moved because of the extraction of a neighboring tooth, or because of the gross movement of the tooth in the jaw.

CEMENTOBLASTS. The cementoblasts lie upon the cementum of the tooth as thickly as the osteoblasts upon the bony wall of the socket and perform the same function for the cementum as the osteoblasts perform for bone. They are instrumental in the laying down of the calcium salts in the building of cementum, and certain of their number are left in the cementum as living cells, which are

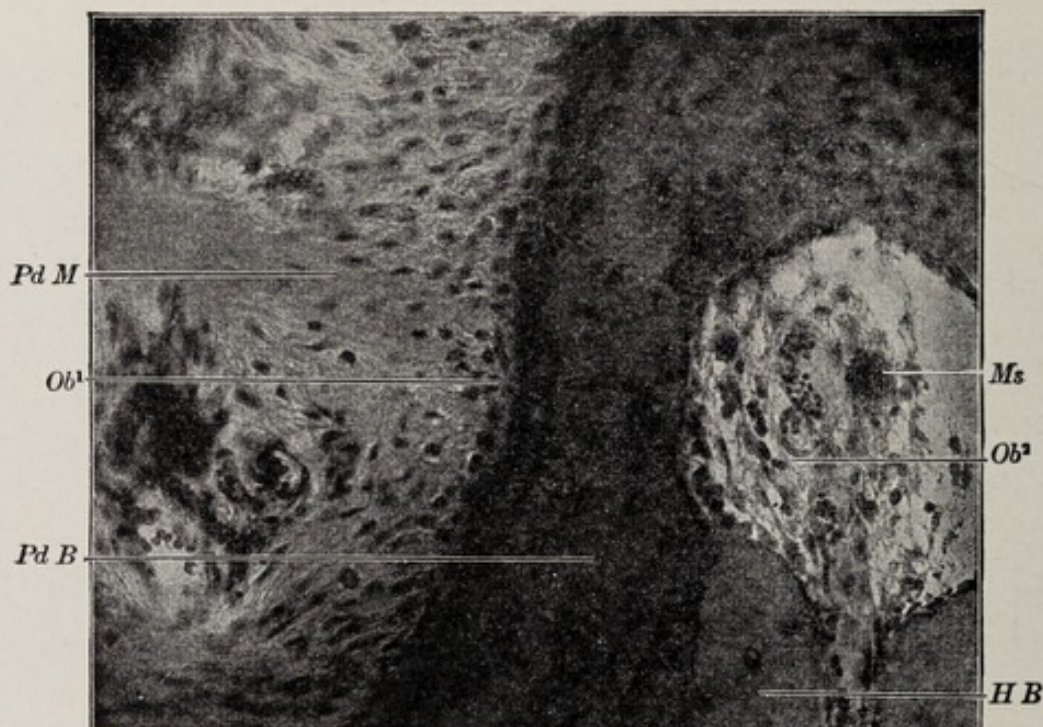


FIG. 1269. Penetrating fibers of peridental membrane in bone. Noyes.

referred to as cement corpuscles, the same as osteoblasts are left in the bone as bone corpuscles.

A row of cementoblasts may be seen in Figure 1270, lying in the peridental membrane near the cementum, see cb. Figure 1272 is a drawing of a section through the peridental membrane in a plane parallel and very close to the surface of the cementum. The fibers which are attached to the cementum are indicated as round, white areas, while all of the space between the fibers is occupied by cementoblasts. The cementoblasts are very irregular in form, as shown in Figure 1273.

While all of this is true in a general sense, there is the differ-

ence already mentioned that the bone has in itself the function of repair of resorptions, because it is furnished with a circulation of blood, which penetrates in its influence to every part of the bone tissue, while the cementum has no blood vascular system and has no power of self-repair. So far as has ever been demonstrated, it receives no sustenance whatever through the dentin, although connections from the dentinal tubuli with the lacunæ of the cementum are observed in many specimens. All such repairs and all the laying down of the new cementum is done by the cementoblasts, which are a part of the peridental membrane. See Figures 1226 to 1228.



FIG. 1270. Horizontal section through portion of root and peridental membrane. D, dentin; C, cementum, Cb, cementoblasts, Ec, epithelial cells, Pm, peridental membrane.

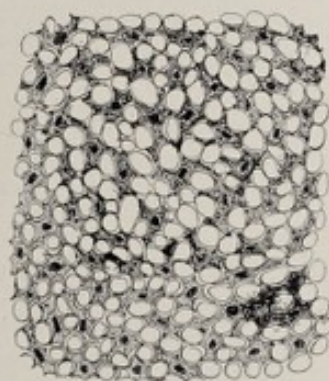


FIG. 1272.



FIG. 1273.

FIG. 1272. Cementoblasts, in situ, with cross sections of the principal fibers of the peridental membrane of the pig, from a section cut parallel and close to the surface of the cementum.

FIG. 1273. Cementoblasts isolated to show the irregular forms of these cells.

EPITHELIUM. Among the tissues of the peridental membrane there is a plentiful distribution of epithelial cells. These lie for the most part close to the cementum but never touch it. They are mingled among the principal fibers, generally in the form of strings, sometimes clubbing together so as to be several cells thick, but often in strings of single cells touching each other. These occasionally form loops which extend outward into the substance of the membrane for one-half its thickness, or more, and then dip back again to a position near the cementum. These cells are

found everywhere around the root of the tooth, but in general the strings are so disposed as to run lengthwise of the root. Clusters of epithelial cells are shown in Figure 1270, marked Ec. This illustration gives a very excellent idea of their general arrangement.

They are remnants of the sheath of Hertwig and are found in all the animals of the higher type, as well as in man. They belong to the tissues of the peridental membrane, but their function has been a question for many years. There is considerable evidence that these cells play a part in the tissue changes which occur in infections of the peridental membrane and particularly in the formation of granuloma and cysts about the apices of roots. These conditions are discussed elsewhere.

Alveolar Process

ILLUSTRATIONS: FIGURES 1276-1281.

The alveolar process is the projection of bone which grows up around the roots of the teeth, and forms the sockets in which the roots of the teeth are held by their membranes.

These sockets are the alveoli of the teeth, or each socket is the alveolus of a tooth. The word alveolus means a hole. The alveolar process is the wall of bone around the hole. This is not a separate piece of bone but is continuous without demarcation with the bones which form the maxillæ and the mandible. There seems to have been no rule among writers on dental subjects as to the use of the singular and plural forms, alveolar process and alveolar processes.

The peridental membrane, as united to the cementum on the one side and to the alveolar wall on the other, connects and binds together the root of the tooth and its alveolar process, thus holding the tooth in its position. See Figures 1257, 1258 and 1260. There is but one alveolar process in each jaw, which passes around the arch in a single bony projection in which there are the number of alveoli for the accommodation of the roots of the teeth. In most cases the projection of the alveolar process above the body of the bone is not sufficient to accommodate the full length of the roots of the teeth, and the alveoli are sunk into the body of the bone so far as may be necessary.

The alveolar process does not quite cover the gingival portion of the cementum, but stops about two millimeters short of the cemental line of the tooth, different specimens varying somewhat. The crest of the alveolar process is therefore always lower than the cemental lines of the teeth.

The alveolar processes are bone, with all of the endowments of the bones in general. Their blood supply is richer than that of most bones, their Haversian canals are larger, and the amount

of blood passing through them is greater than in the bones in general. The nerve supply is also richer. To accommodate this very rich circulation, the alveolar processes are permeated by many Haversian canals and a large number of these pass through directly or indirectly from the side of the mucous membrane to the side of the peridental membrane, or the reverse, giving to the peridental membranes a rich collateral circulation through the alveolar wall.

Wherever the bone constituting the alveolar wall is considerably thickened, it has a fairly solid cortical, or surface portion, toward the mucous membrane side, and a thinner, fairly solid portion on the side next to the peridental membrane. In the cen-

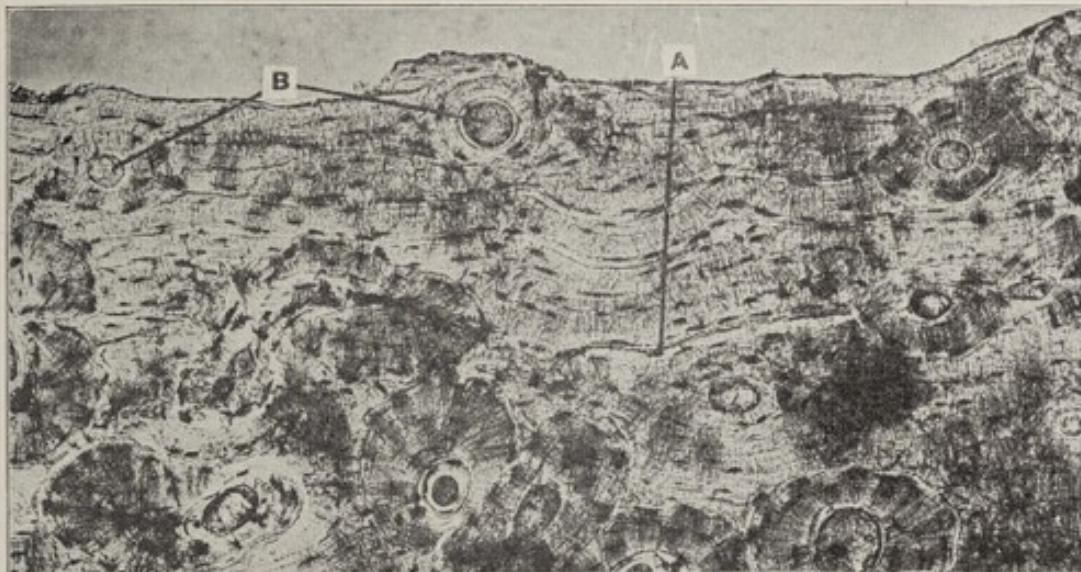


FIG. 1276. A photomicrograph from a cross section of bone from the human femur from a young person. A, This line crosses laminae of subperiosteal bone. B, These lines point out Haversian system bone. These Haversian systems, that are seen to form the bulk of tissue, are formed by the absorption of the original subperiosteal bone and building in the Haversian system bone.

tral portion between these two, the bone is much less dense. Indeed, wherever there is thickness enough to permit it, it becomes cancellous or medullary. It is divided in many directions with thin laminae of bone, uniting the whole together in a strong mass, in which the interspaces are filled with connective tissue, blood vessels and nerves, giving it a physiological activity closely related to the ordinary connective tissues. Figures 1276 and 1277 illustrate subperiosteal and Haversian system bone.

The alveolar process rises much higher above the true form of the maxillary bones in the front part than it does in the back part of the mouth. It is therefore higher about the incisors and cuspids and lowers away toward the back part of the mouth until, in the lower jaw particularly, the alveoli for the second and third molars are often hollowed out in the body of the bone. Indeed in many cases the alveolar walls on the lingual sides of these teeth are built out around them as they lie one-half, more or less, out

on the lingual side of the bone. In the upper jaw a much more decisive alveolar ridge is maintained even to the third molars, but this part of the ridge is much lower than in front.

DEVELOPMENT OF THE ALVEOLAR PROCESSES. One who has followed carefully the development of the teeth and the dental arches in the clinical way, together with the occlusion of the teeth, in many children, and the malocclusions which occur among them, will have discovered that the teeth are not made to fit their alveoli, but that the alveoli are made to fit the teeth. The teeth, during the development of the arches, go on with their movements as the bones of the face are growing and expanding from the face of the child to the face of the adult. The teeth are assuming the adult positions by which they are assisting in rounding out the prom-



FIG. 1277. Lengthwise section from the same bone, as illustrated in Figure 1276, showing the Haversian systems and their canals cut lengthwise. A, Subperiosteal bone. B, Haversian canal.

inences of the adult features. During this time the alveolar processes are keeping even pace with the movements of the teeth. As the teeth move forward, the alveolar walls are absorbed here and built out there, to accommodate the movement. See Figures 1425 to 1430. If it should happen that one or more teeth are taking wrong positions, bringing about malocclusions, they are not limited or perceptibly held back by their alveoli; but the alveolar walls will be built to fit the teeth in the malposition. If a cuspid tooth is crowded forward out of its normal position, for instance, the walls of its alveolus accommodate themselves to this movement. It is not crowded out of its alveolus. It does not lose the fitting of an alveolar wall around it because the tooth has taken a wrong position.

WHEN THE TEETH ARE MALPOSED. When teeth are in malpositions from some cause, and the proper devices are used to

direct the teeth back into normal position and to stimulate the growth of the bones in such directions as to bring the features to the normal form and *allow the teeth* to come into proper positions, the walls of the alveoli about the teeth will *grow the changes* to accommodate the movement. In cases in which supernumerary teeth have diverted one or more teeth from their normal places, they will come to their normal positions soon after the supernumerary teeth are removed; or if the cuspids have not fully erupted on account of lack of space, they will generally move into place if the proper space is made for them.

WHEN TEETH ARE EXTRACTED. Finally, if further evidence were needed to show that the alveolar process is the physiological servant of its related tissues, and especially of the teeth, the results which occur when the teeth are lost may be cited. Straightway the alveoli are in part filled with a new growth of bone and the prominences of the alveolar walls are removed by resorption. Then a *residual alveolar ridge* is all that is left. In this there is no trace of the former alveoli. The gingivæ which rested upon the crest of the alveolar process, with all of their appendages, are gone. The conditions of the formation of this residual alveolar ridge, the influences which give good form and which give bad form, are very important. They are discussed elsewhere.

In connection with the study of cases of chronic suppurative pericementitis, in which the bone of the alveolar process is destroyed along the side of the root; also of cases of chronic alveolar abscess, in which the bone is destroyed about the apex of the root, attention is called to Figure 1281.* This is a longitudinal buccolingual section near the center of a twenty-one day extraction wound. This shows the resorption of bone from the projections of the alveolar process and the building of bone in the depth of the socket. It is important to remember that this illustrates the physiological tendency of the lateral walls of the alveolar process to be resorbed, while the apical portion of the socket is filled with bone. This applies to all conditions in which the peridental membrane is detached from the root. Thus, in cases in which the peridental membrane is detached along the side of the root, the physiological tendency is to bring about resorption of the corresponding portion of the alveolar process, while in cases of chronic pericemental abscess, the destruction of bone about the root apex results from the suppurative process, and there is the constant physiological tendency to build in new bone to replace that which has been destroyed. This will be referred to in discussing both of these pathological conditions.

RESULTS OF A BREAK IN THE PERIDENTAL MEMBRANE. Another point of importance is that there will remain no alveolar process

* A Histological Study of the Healing Process, Following the Extraction of Teeth by the Forceps and the Surgical Method. Warren R. Schram. Thesis submitted in partial fulfillment of requirements for Master's degree, Northwestern University Dental School, 1929.

about the side of any part of the root of a tooth without a peridental membrane. The peridental membrane makes the connection between the tooth and the alveolar process, and when this is broken in any part it is as if the tooth were lost, so far as that particular part of the alveolar process is concerned. This portion of the alveolar process is resorbed and may be replaced by granulation tissue, which does not show in a radiograph.

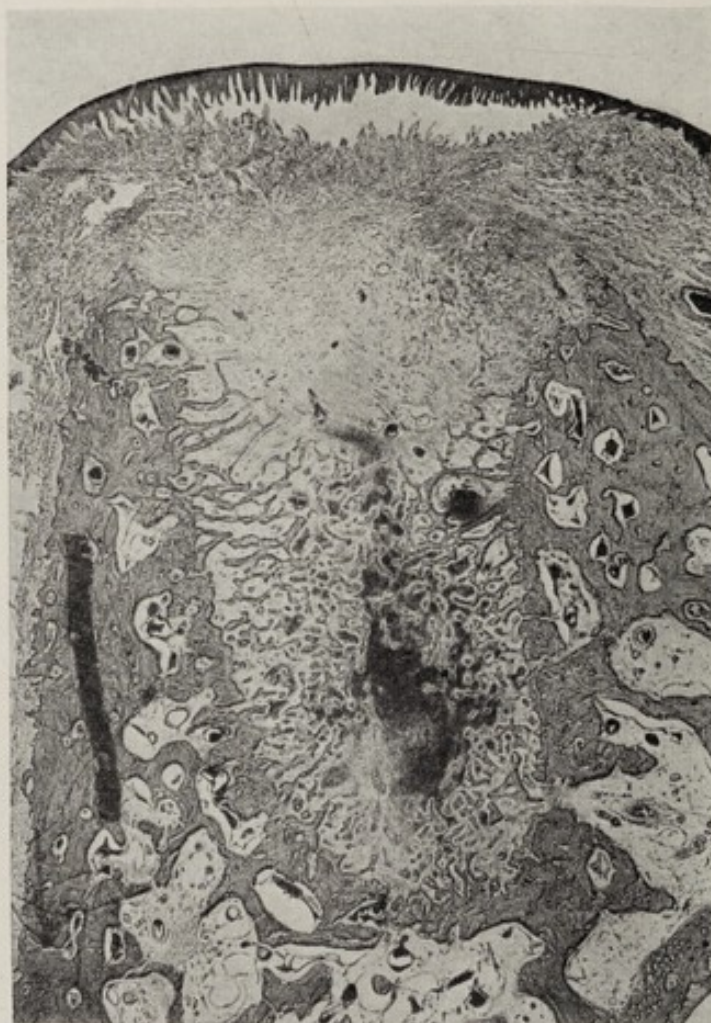


FIG. 1281. Vertical bucco-lingual section through the bone of the lower jaw of a dog, twenty-one days after a forceps extraction, showing the resorption of bone in the region of the crest of the alveolar process and the building in of a new bone in the depth of the socket.

MOVEMENT OF TEETH SUBSEQUENT TO EXTRACTIONS. Another action which often does much harm is apt to follow the extraction of any one of the teeth. Suppose, for instance, that a first molar is extracted when the person is twenty years old and the formation of the arches is practically completed. The socket of this tooth, which is the broadest in the mouth in the mesio-distal direction, is quickly filled in with bone, and its prominences, with the gingivæ which rested upon them, are removed by resorption. In the gum tissue which covers this, a hard, dense cicatrix is formed. The fibers of the peridental membrane, which formerly passed

from tooth to tooth over the crests of the alveolar septal processes, and which have been torn across about midway between the two teeth both to the mesial and distal of the extracted one, are then attached to this cicatricial tissue. This shrinks very materially as the rule. This shrinkage, with the pull of the trans-septal group of fibers, tends to draw the second and third molars forward, causing them to lean toward the mesial, so that their occlusal surfaces do not meet the opposite teeth properly. The bicuspid may be similarly drawn distally. The result is a disturbance of the occlusion of these teeth, which is liable to lead to their loss some time in the future, because of the derangement of the contact points. In some cases, the stability of the teeth of the opposite arch and the occlusion, particularly if the cusps are long, may prevent the movement of the teeth, as just described.

PHYSIOLOGICAL MOVEMENTS OF THE TEETH.

The use of the teeth in mastication results in *normal* wear of both the occlusal surfaces (also incisal edges) and the proximal surfaces of all of the teeth. This wear should be differentiated from that to which the term *abrasion* has been applied. Abrasion is an *abnormal* wear; the teeth wear away more rapidly than they should in relation to their use. Abrasion is discussed in Volume I, page 316.

The normal wear of the occlusal surfaces occurs very gradually as a result of the frictional contact of these surfaces in mastication. The wear of the proximal surfaces occurs at the position of the contact points as a result of the slight bucco-lingual or labio-lingual movements of the teeth in mastication. The wear of both the occlusal and proximal surfaces of the molars, bicuspid and cuspid is more pronounced than that of the incisor teeth. The proximal wear may be so slight that it is not noticeable as one examines the teeth of a person of middle age, yet it may be seen in practically all cases if, for any reason, the teeth are extracted. When one considers that there are thirty proximal surfaces in each arch, the combined wear may be considerable.

In the continuously growing anterior teeth of rodents there is a correlation between growth and wear. The wear of use is compensated by the growth and the teeth are of practically the same length continuously.

Nature's compensatory adjustment for the wear of the human teeth lies within the supporting structures and consists of the occlusal movement of the teeth to compensate for normal wear, also the mesial movement of all of the teeth to balance the wear of the proximal surfaces and to maintain tight contacts. There appears to be the phenomenon of continuously exerted force to maintain both the occlusion and the proximal contacts.

DRIFTING OF THE TEETH. This term and the term *wandering of the teeth* have been applied to the above described physiological

movements, which are always active to maintain the most effective use of the teeth. It seems more appropriate to confine the term *drifting*, which may be defined as an *aimless wandering*, to those cases in which the physiological movement goes astray because of the loss of teeth, or the loss of function of a tooth from any cause.

When a tooth has lost its occlusion because of the loss of one or more teeth in the opposite arch, it will usually become "elongated," or will move farther and farther occlusally by the continued, but unopposed, physiological force. The movement may continue until the occlusal surface is in contact with the gum of the opposite arch. In such a movement, the contacts with the proximating teeth may be weakened or abnormally broad. In some cases, particularly when several teeth of the opposite arch are missing, all of the supporting structures will accompany the teeth in the movement, so that a section of the jaw is "elongated" with the teeth.

Similarly, when a tooth is extracted in either arch, as, for example, a first molar, the second molar will tend to move mesially in an apparent effort to close the space. Another and even stronger force is concerned in this movement, as is evidenced by the tendency in such a case, of the second bicuspid to move distally, in opposition to the normal mesial trend. In the healing of the first molar socket, there seems to be exerted a pull upon the trans-septal and other proximal surface fibers of the peridental membranes of both the second bicuspid and second molar, to draw them toward the vacant space. The term *drift* may be appropriately applied to these movements, because the normal relations of the teeth have been upset by the loss of the first molar. The same conditions often cause the second molar, upper or lower, to drift distally when the third molar is extracted.

This term may also be applied to those teeth which wander labially, buccally or lingually from their normal positions in the arch as a result of some disturbance in the balance of forces, as in cases in which teeth are occlusally functionless, but have no discoverable disease or injury to the peridental tissues.

History of the Diseases and Treatment of the Investing Tissues of the Teeth*

GEORGE B. DENTON, PH.D.

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ILLUSTRATIONS: FIGURES 1282-1283.

FIRST PERIOD—PRIOR TO 1821.

IN PREHISTORIC TIMES. Pericementitis, like other dental ills, undoubtedly existed from earliest times. In the Rhodesian skull, which represents prehistoric man about thirty thousand years ago, there are resorptions of the border of the alveolar bone which appear to be the result of pericementitis.

IN THE ANCIENT WORLD. Many instances of similar extensive destruction of the process are to be found in Egyptian mummies, evidencing the ravages of this disease. Furthermore, some of the ancient peoples — such as the Phoenicians and Etruscans — must have suffered from disease of the investing tissues, as various splints and wirings are extant for stabilizing loose teeth.

In the first century, Celsus, the most famous of the Roman medical writers, recognized periodontal disease when he spoke of teeth "occasionally loosened either by reason of weak roots or from the gums' decaying."

IN THE MIDDLE AGES. Throughout the Middle Ages, *commotio*, or instability of the teeth, was always listed among dental affections. Guy de Chauliac, 1363, the most renowned medieval European surgeon, mentioned pericementitis, and briefly explained it according to the humoral pathology of the period. Similarly, in *Zene Artzney*, 1530, the first work wholly devoted to the teeth, one chapter, the ninth, deals with loose teeth. "Dentium commotio," explained the author, "is when one's teeth loosen and are disposed to fall out before their natural time. This happens either from relaxation, weakness, or disease of the gums; or from the suppuration of the parts which hold the teeth, which occurs when an excretion from the head falls on the gums or roots of the teeth, and by its bad influence relaxes them, or from diseases of the stomach, in which case bad excretions arise from it and injure the gums." Cathartics, various mouth washes, and actual cautery were suggested as remedies.

* Abstracted from a History of Dentistry, in preparation.

IN THE EIGHTEENTH CENTURY. By the middle of the eighteenth century, pericementitis had become a well recognized entity in dental medicine and surgery; and from the time of Fauchard's so designating it in 1746, it soon became generally known as *scurvy* or *scorbutus of the gums*. Fauchard gave a satisfactory clinical picture of it:

"There is another species of scorbutus, of which I think no other author has yet taken the trouble to speak, and which, without affecting other parts of the body, attacks the gums, the alveoli, and the teeth. Not only gums, which are soft, livid, elongated, and swollen, are subject to it; but those which escape these weaknesses are not free from this affection. It is recognized by a rather sticky, white pus, which is made to exude from the gums by pressing the finger rather firmly upwards on those of the lower jaw, and downwards on those of the upper.

"This pus often comes from between the gums and the body of the alveolus, and sometimes from between the alveolus and the root of the tooth; it takes place more frequently at the external side of the jaws than at the internal, and more often at the incisor and canine teeth of the lower jaw than at those of the upper, which are, however, more ordinarily affected by this misfortune than are the molars."

All eighteenth century writers were aware that extraction of the affected teeth would cure the disease. Most of them regarded any other measure as merely palliative. Fauchard advocated a mild form of treatment, consisting of hygienic measures, astringent mouth washes, and massaging with the fingers dipped in anti-scorbutic lotions. Bourdet, 1757, advocated cautery and gum resection.

The earliest dentists in America, who practiced in the later eighteenth century, were doubtless familiar with pericementitis. Those who published books or articles — namely, Woofendale in 1783, Gardette in 1790, and Flagg in 1822 — described the disease and made clinical observations with regard to it.

SECOND PERIOD—1821 TO 1867.

KOECKER AND HAYDEN. During the early nineteenth century, for the most part, dental writers took very little interest in pericementitis, although most of the early books contained the commonplace comments upon the disease. At the beginning of the third decade, however, two interesting papers made their appearance in medical journals. The earliest of these, 1821, was Leonard Koecker's "An Essay on the Devastation of the Gums and the Alveolar Processes." This article focused attention on a single cause, calculus, and on a single treatment, scaling. In contrast to most of his predecessors, Koecker believed in the absolute cure of the disease by this simple method.

Koecker's article called forth a reply by Horace Hayden in the following year. Hayden, conversant with the eighteenth century French literature, presented a more pessimistic view. He believed that there were two types of pericementitis, one caused by calculus and usually curable, and another caused by systemic conditions, such as constipation, sedentary habits, bad diet, corpulence, etc., which was hopeless.

For the next forty years there were no important developments in American views on pericementitis. Koecker's views, probably because of their optimism and simplicity, became characteristic of the American practitioner; and although the possibility of systemic causes was occasionally alluded to, calculus was pretty generally accepted as the principle, if not the only, cause of the disease.

CLINICAL OBSERVATIONS AND PROBLEMS. One hundred years ago most of the clinical observations on pericementitis had already been made. Among these were the following: The disease, although not confined to any age, is more usual with persons over forty years old, and is prevalent with older people. The lower anterior teeth and the molars are most susceptible, although all the teeth are subject to attack. The position of the teeth with regard to the opening of the salivary ducts seems to have an effect upon their susceptibility. Inflammation, suppuration, fetor, looseness of the teeth, and pain are commonly present. There is recession of the gums, resorption of the sockets, and sometimes extrusion of the teeth. Always when neglected, and sometimes even with the best treatment, teeth are lost, and the patient ultimately becomes edentulous. The presence of calculus on the affected teeth and general uncleanness of the mouth were observed as common, but not inseparable accompaniments. It was noted that the disease was likely to occur more often in mouths immune to dental caries.

Many of the persistent problems with regard to pericementitis had also already arisen. These were concerned with the question whether the cause was local or systemic; where the essential lesions were located; whether the disease was curable; and the extent to which restoration of the involved tissues was possible.

STUDY OF CALCULUS. In consequence of the prevailing notion that calculus was the cause of pericementitis, some study of the origin, nature, and deposition of calculus took place. Although most of the earliest articles on calculus were concerned merely with reporting cases of unusually large deposits, or with methods of removing calculus, some interest was manifested in the more fundamental problem of its production.

During the early nineteenth century, chemical theories of the deposition of calculus had been growing up, probably under the influence of foreign investigation. Among these, the theory that the inorganic salts of calculus are precipitated by the escape of carbon dioxide from the saliva upon secretion of the latter, became the favorite explanation, and was represented by Watt, 1879, Niles, 1881, Burchard, 1895, and Kirk, 1911.

THIRD PERIOD — 1867-1885.

The most prominent influence on American views and practice with regard to pericementitis during the decade following 1875 was John M. Riggs, and this period may well be called the "era of Riggs." His work represents the highest point in the development of the belief that calculus is the sole cause of pericementitis, and of the practice of removing it as the chief procedure in the treatment of this disease.

According to Riggs' own claims, he had engaged in the study and treatment of pericementitis from about 1840, when he began practice. His work, however, did not attract prominent public notice until in the later sixties. In 1866 Riggs probably presented his views before the American Dental Association, and gave a clinic. In 1867 he participated in the discussion of salivary calculus before the Connecticut Valley Dental Society, and gave a clinic in which he treated a case of pericementitis. Two years later, upon motion of Dr. Goodrich, the subject of the 1867 clinic, the Connecticut Valley Dental Society adopted resolutions claiming for Riggs "the credit of originating and first publicly describing a new treatment for the cure of inflammation of the gums and resorption of the alveolar processes." Thenceforth, Riggs' appearance upon the programs of dental conventions became more frequent, and in 1881, at the International Medical Congress, he discussed pericementitis at some length. From this time until his death in 1885, this subject could scarcely be discussed in any dental meeting without his claims and methods being brought up.

Even during his lifetime, Riggs seems to have acquired something of a mythical character. This is reflected in the almost superhuman skill and almost universal success which were ascribed to him by his followers. Several circumstances of his character and career probably contributed to the building up of his reputation. One of these was undoubtedly the obscurity and vagueness with which his views and practices were invested even while he was daily employing them. There are only three published records of his views in his own words, and in no instance did he give detailed instructions verbally as to the procedures in his operations.

Although Riggs briefly described his procedure in the treatment of each stage of the disease, he nowhere gave sufficient detail for an accurate understanding of his method. He rather emphasized the difficulty of the operation, and the need of skillful instruction and long practice.

"It would take many pages to describe the relative position of operator to the patient," he wrote, "the mode of holding the instrument; its various motions on and about the tooth; its progress down to the line of health of the tissue; and its clean and perfect work on the tooth in its passage to that line. The dentist must distinguish by the delicacy of touch of the fingers, what his instrument impinges, whether limey concretions, or abnormal ulcerative peri-

dental membrane; or the regular or irregular absorption of the alveolus, and its condition of health or of disease."

He emphasized that it was necessary not only to carry the scaling to the limit of the calculus, but to go even beyond it, and "break up the abnormal soft tissues, and scrape down to the edge of the bone." In the controversy with regard to the originality of the Riggs' operation, this scraping of the border of the alveolar bone remained, according to his disciples, as the essential contribution of Riggs. Nowhere did he describe his famous set of six instruments for performing these operations.

Riggs criticized the treatment employed by other practitioners. "Some treat it by stippling in acids underneath the gums, thinking thereby not only to dissolve away the tartar, but the necrosed bone. Another writer takes off patches of the diseased tissue, and another a strip of the gum from wisdom-tooth to wisdom-tooth. This treatment he could only characterize as simply barbarous."

FOURTH PERIOD — 1885-1899.

The period immediately following the death of Riggs in 1885 was characterized by a number of new developments with regard to pericementitis, many of them partaking of the nature of revolt against his views, then dominant. For one thing, many dentists rebelled against the use of the term "Riggs' disease" to indicate this condition. The name was objected to, not only because it was considered insufficiently descriptive, but because many felt that Riggs' contribution had been limited entirely to treatment.

INTRODUCTION OF THE TERM PYORRHEA ALVEOLARIS. The term *pyorrhea alveolaris* had been making its way slowly into the usage of the American dentist for some years prior to Riggs' demise. The origin is probably to be found in the work of Toirac, 1823, in the form *pyorrhée inter-alveolo-dentaire*. Desirabode, 1843, in discussing the subject, borrowed Toirac's designation; and when his work was translated into English, 1847, the term was rendered *inter-alveolo-dental pyorrhoea*. This was probably the first use in American literature. Other early usages were as follows: While Truman was editor of the *Dental Times*, there appeared, in translation, in that journal for April, 1868, an article by Adolf zur Neden concerning Magitot's views on pericementitis. The term *pyorrhea alveolaris* (taken over directly from the German) appeared in this article. *Pyorrhea alveolaris* was also the term used in the English translation of Wedl's *Pathology*, 1872. An article in the *Dental Cosmos* for May, 1875, signed J. T., and undoubtedly from the hand of James Truman, also employed this designation, and has usually been regarded as the earliest instance of the use of *pyorrhea alveolaris* in American dental literature.

The term was definitely called to the attention of the profession by Rehwinkel in a report before the American Dental Association in 1877, and began to be commonly used in America, probably between 1880 and 1885.

SERUMAL CALCULUS. The simple conception of the calculus etiology entertained by Riggs was elaborated by his contemporaries and immediate successors. Although a distinction between calculus on the crowns of teeth and calculus beneath the gums and on the roots had been recognized since early in the nineteenth century, little had been made of it until L. C. Ingersoll emphasized it in 1880. He considered that, whereas calculus on the crown came from the saliva as generally supposed, that deposited on the roots in the absence of a pocket, was derived from the *liquor sanguinis*. Salivary calculus he believed to be the etiological factor in pericementitis. He considered the other form, which he called *sanguinary calculus*, to be a result, and not a cause, of an inflammatory process in the pericemental tissues. These inflammatory conditions about the root he was able definitely to account for only in connection with periapical abscess.

Black in 1882 supported, with some modification, the view of root calculus held by Ingersoll. He gave it the name of *serumal calculus*, as he considered it exuded as a modified form of the blood fluids. He indicated that it might be located on the enamel, within the gingival crevice, and it might also be found deep on the root. He agreed with Ingersoll that it must be preceded by an irritation of the excreting tissues. Unlike Ingersoll, he believed that this calculus was also an irritant contributing to the progress of pericementitis. This view was held in his discussion in Litch's *American System of Dentistry* in 1886, with the exception that he admitted the possibility of deposition without a preceding irritation of the tissues. This was practically his view in the *Special Dental Pathology*, 1915. He also, 1911, made extensive study of the method of deposition and character of both serumal and salivary calculus.

MICRO-ORGANISMS. Interest in micro-organisms as causative factors in dental disease increased during the eighties. Among the German writers, Wedl, in his *Pathology*, as early as 1870, mentioned bacteria in pericementitis, and after him, fuller studies were made by Witzel, Arkövy, and Iszlai.

James Truman seems to have been the first in America to mention bacteria in connection with pericementitis. The subject was brought to the attention of the profession by Rehwinkel's report before the American Dental Association in 1877. Black treated the subject at greater length in an article in 1882, and also in his contribution to Litch's *American System of Dentistry* in 1886. At this time he recognized two types of pericementitis — the calcic, due to salivary and serumal calculus, and the phagedenic. Black was convinced that this second type was of microbic etiology, and would have preferred a more descriptive name if he had been able to demonstrate conclusively its cause. Black was at this time regarded as the chief champion of the bacterial etiology in America.

The most important problem, of course, was the etiological significance of the bacteria found; and while some of the observers immediately jumped to the conclusion that pericementitis was

caused by specific organisms, most of them expressed considerable doubt throughout this period.

The active participation of bacteria in the later stages of pericementitis was soon accepted; but the question whether the organisms were specific in character and initiated the lesions of the disease, or whether they were secondary to some peculiar condition of the tissues, was a matter of dispute. "As regards the participation of bacteria in pyorrhea alveolaris," declared W. D. Miller in 1890, "our present knowledge of suppurative inflammations compels us to consider the former as the cause of the suppurations incident to this disease. According to this conception, pyorrhea alveolaris is not caused by any *specific bacterium*, but various bacteria may participate in it, just as in suppurative processes not only one but generally various species have been found."

RELATION OF GOUT TO PERICEMENTITIS. In brief, the theory of the relation of gout to pericementitis was: first, that persons disposed to gout were also disposed to pericementitis; second, that gout was caused by a superfluity of uric acid in the blood; third, that the condition of the peridental structures in pericementitis was brought about by the uric acid in the blood; and fourth, that calculus on the teeth was similar to the deposits of gout in the joints, and that these deposits contained uric acid. Pierce demonstrated by chemical test the presence of uric acid in calculus deposits on teeth of pericementitis patients.

G. V. Black, in 1894, had the dental calculus in fifty-one subjects tested. The presence, or absence, of the following characteristics was recorded for each subject: (1) gouty diathesis, (2) gingivitis and pericementitis, and (3) uric acid in the calculus. He did not find sufficient correlation among these characteristics to substantiate the gouty diathesis etiology.

The next extensive investigation of uric acid in calculus was made by Talbot. He had the calculus of several groups of teeth, 950 teeth in all, examined for the presence of uric acid. His results showed that not more than six per cent of the teeth in any group yielded positive evidence of uric acid.

TREATMENT. The principal developments of treatment during the period from 1885 to 1900 were modifications of Riggs' scaling methods. These diverged in two directions. Either they were designed to give greater delicacy, refinement, and elaboration to the operations for removing calculus; or they were designed to intensify the surgical aspects of the operation.

Riggs' operation, as carried out both by himself and his disciples, had the reputation of being severely painful, and undoubtedly involved the laceration and injury of much tissue. The lack of knowledge of the peridental tissues and their functions, and the extreme injury to which they were subjected, are well illustrated by the following excerpts from an article by one advocate of radical surgical treatment.* After a local anesthetization of the affected

*Dental Cosmos, Vol. 41, 1899, p. 617.

tissues, a thin chisel-shaped, flexible lancet was "carried down the side of the tooth to the alveolar process and passed all the way around the tooth, thus completely separating it from the overlying gum. . . ." "If no discoverable pocket be present," he said, "the lancet is just as freely used." After access to the root was thus gained, he proceeded "to scrape and chisel heroically all around, especially about the part covered by the pocket." This was not "to be merely scraped sufficiently to remove the diseased part of the membrane," but the cementum itself was removed to a considerable depth. Then the overlying gum was "to be thoroughly lacerated, and diseased portions of the process removed."

And he proceeded, "Now, with a very sharp, fine-pointed excavator fine grooves are cut in the cementum well down under the gum. The object is to afford a better place for deposit and attachment of new tissue. . . . These grooves are often cut with a small-size bur extending to a considerable depth below the alveolar process. Usually about four grooves are cut on each root. Into these grooves new bony tissue is soon deposited, and greatly tightens the tooth. . . .

"The pockets are now washed out and pure sulfuric or hydrochloric acid is applied with a platino-iridium wire, flattened at the point. This acid is repeatedly applied, wiping away the blood which oozes quite rapidly out of the wounded pocket. The object is to keep the acid in contact with the scraped part of the cementum long enough to decalcify the surface. I would emphasize the importance of doing thorough and heroic surgical work, as the medication is useless without it. Too much stress cannot be laid on the importance of thoroughly and deeply scraping the roots and lacerating the tissues. It is almost impossible to overdo it. Of course, we get violent inflammation, but that is what we want. . . . Scrapers should be stiff enough to allow considerable force to be used, and should cut like excavators."

Those who believed in a milder treatment for the removal of calculus, devised more delicate and efficient scaling procedures. I. A. Freeman presented a careful analysis of such a method before the Chicago Dental Society in 1897. There was a tendency toward the development of smaller, and to some extent more specialized, instruments than those used by Riggs.

The purpose of extremely thorough cleansing of the root, combined with the aim of keeping the margin of the gum intact, led to a type of operation involving surgery and scaling. Sometimes vertical incisions were made along the axis of the root, which gave access to the pocket.

Although gum resection was occasionally practiced, this operation was, in the main, condemned, because it was thought that the margin of the gingiva must be preserved if there was to be any restoration of the destroyed tissue.

FIFTH PERIOD—1899 TO DATE.

NEW DEVELOPMENTS IN THE STUDY OF PERICEMENTITIS.

HISTOLOGICAL STUDY OF PERIDONTAL STRUCTURES, NORMAL AND PATHOLOGICAL. The period beginning with the later years of the past century and continuing through to the present time has been characterized by at least one entirely new point of view in the approach to the pericementitis problem. This is the introduction of the histo-pathologic study of the disease. As early as 1870, William H. Atkinson pointed out that an adequate study of pericementitis "involved more minute knowledge of anatomy and physiology than those claiming to be the best pathologists extant have yet attained;" and that the investigator "must become familiar with the character of bodies too small to be seen by the unaided natural eye."

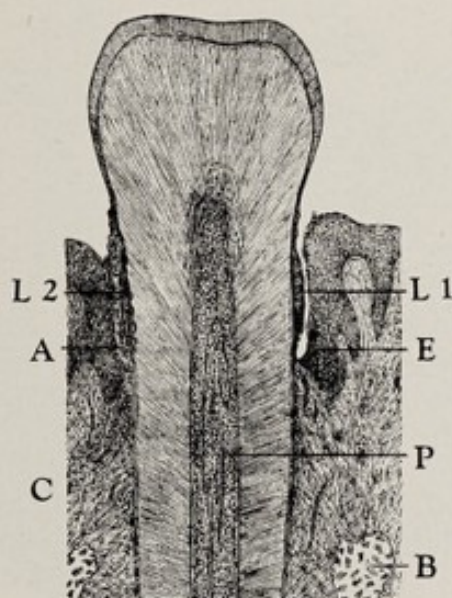


FIG. 1282. Pericementitis in a sick kitten. Probably the first microscopic study of pericementitis by Wm. H. Atkinson, in 1888. Description: "P, pulp; B, bony socket; C, fibrous connective tissue; E, epithelium; L-1, cluster of leptothrix deprived of its lime salts; L-2, cluster of leptothrix upon eroded neck of tooth and entangled with pus corpuscles; A, cavity filled with pus in continuity with the pericementum." *Dental Cosmos*, Vol. 30, 1888.

As late as 1897 G. V. Black declared in a discussion: "There is this thing that is apparent in all the discussions upon this subject; we have not studied the histological character of the membrane sufficiently, neither have we made pathological studies that are at all sufficient for the determination of this subject. . . . Until we can make these studies we may talk and talk and talk, and we will still only be guessing."

Before a microscopic study of the pathology could be undertaken with profit, it was necessary that the histology of the normal structures involved should be understood. Although the hard tissues had been investigated microscopically since about 1835, the soft tissues, with the exception of a little work on the dental pulp, had been neglected. It was not until Black's articles on the peri-

dental membrane and other supporting structures of the teeth appeared in 1886-1887, that detailed knowledge of this field was supplied. The work contained descriptions of all the supporting tissues of the teeth — the periosteum, the alveolar bone, the peridental membrane, and the cementum — and was illustrated by sixty-seven drawings of these structures from microscopic sections. There is little indication that even then the importance or relevancy to the study of pericementitis was appreciated.

In an article in 1899 Black carried his studies of the peridental membrane further, showing the distribution of the fibers and certain other structures. Frederick B. Noyes, who made the photomicrographs for Black's article, continued to study the normal histology of the peridental membrane, and summarized his findings in the first edition of his *Dental Histology*, 1912.



FIG. 1283. First histo-pathological study of pericementitis, by Eugene S. Talbot in 1896. Description: "a, dentin; b, cementum; c, inflamed, thickened peridental membrane." *Dental Cosmos*, Vol. 38, 1896.

Probably the earliest attempt to study pericementitis in actual microscopic sections, at least from the point of view of lesions in the structures involved, was that of William H. Atkinson in 1888. He presented a study of a loose and diseased tooth of a young kitten, which was accompanied by three drawings from sections. One of these drawings is reproduced in Figure 1282.

The first real histo-pathological study of pericementitis was reported on by Eugene S. Talbot in January, 1896. At the time, he published two photomicrographs, showing portions of dentin, cementum, and diseased peridental membrane. These were probably the first photomicrographs of pericementitis ever published. One of these illustrations is reproduced in Figure 1283. Later in the same year he presented before the Section on Dental and Oral Surgery of the American Medical Association a paper in which he

included ten photomicrographs of diseased peridental membrane. The material was obtained from human teeth, extracted because they were loose, and therefore they represented the last stages of the disease.

In 1899 he published his work on *Interstitial Gingivitis*. This contained many photomicrographs of pericementitis as found in the teeth of dogs. In this case it was possible to present sections of all the tissues involved *in situ*. Regarding Talbot's work, the review in the *British Dental Journal* declared, "These are, we believe, the only published photographs (or, indeed, illustrations of any kind) showing the actual pathological change in this disease, and as such are deserving of the highest commendation."

In spite of this beginning by Talbot, the study of the pathology of pericementitis by the microscope proceeded very slowly. Gottlieb, who was probably conversant with most of the professional literature on the subject throughout the world, declared that when he began his studies in 1912, he was able to find only five persons who had studied the tissues involved at first hand microscopically. These were, besides Talbot, Znamensky, 1902, Dependorf, 1903, Roemer, and Hopewell-Smith, 1911. To these perhaps should be added I. N. Broomell, who in 1900 contributed a paper with photomicrographs on the morphology and pathology of the soft tissues about the teeth, most of which dealt with the normal histology.

As early as 1904, Hopewell-Smith had made a study of degenerate processes of the peridental membrane. This was concerned with a kind of senile atrophy. In 1909 he presented before the International Medical Congress at Budapest the first histo-pathological studies of pericementitis in human beings (except those of Broomell) based upon sections of all the tissues *in situ*.

In 1919 F. B. Noyes reported results of several years' work on pathological changes in the peridental membrane associated with gingivitis and pericementitis. In explanation of the vertical progress of the peridental pathosis, Noyes made use of his recent (1918) demonstration of the course of the lymphatics of the peridental membrane.

In 1921 Gottlieb and Fleischmann published their "Contribution to the Histology and Pathogenesis of Pyorrhea Alveolaris." Since then, Gottlieb alone, or in collaboration with some of his pupils, notably Orban, has given the profession a series of studies, mostly histo-pathological, with regard to pericementitis. His work has been characterized by freshness of attack, ingenuity of interpretation, and willingness to revise his opinions.

Perhaps the investigator on this side of the Atlantic whose histo-pathological observations have attracted the most attention is Harold Keith Box of Toronto. He published, in 1924, *Studies in Periodontal Pathology*. Between his findings and those of Gottlieb there is considerable correspondence, although their pathological theories are at variance.

INJURIES. It was not until after 1890 that writers on pericementitis began to urge upon the profession the consideration of

poor dentistry, ill-advised oral hygienic measures, and natural defects in the position of teeth as originating important irritations leading to gingivitis. Of course, there must have been some recognition of these factors from the earliest times, and there was occasionally a casual mention of them. Harris, in 1839, wrote, "Every thing that tends to produce inflammation in the gums and alveolar processes, may be regarded as exciting causes of this disease." Truman, in 1875, also called attention to these irritations, and pointed out that they would be on the increase because of the more extensive use of rubber dams and devices for separation in the filling of teeth. Sanger in 1890 thought that gingival irritation was due to the roughened surfaces of subgingival cavities, the impaction of food between teeth with defective proximal fillings, wedging, overhanging fillings, gold shell crowns, rubber dam remnants, and injuries from ligatures.

The fullest development of this etiology of pericementitis was presented to the profession by G. V. Black in January, 1911. "It now seems to me very curious," wrote Black, "that the dental profession has so long ignored this class of injuries to the septal tissues and gingivæ." In the same year Arthur D. Black stressed the same causes of pericementitis, and substantiated this conclusion in 1913 in a study in which he showed that of 475 patients with gingivitis, 31.6% of the regions were due to salivary calculus, 13.2% to serumal, and 55.2% to mechanical injuries.

PERICEMENTITIS RESULTING FROM OCCLUSAL STRESS. Occlusal stresses as a cause of pericementitis were occasionally mentioned throughout the nineteenth century, and in an article by J. Hardman on "Loose Inferior Incisors," 1884, these stresses were conceived of much in the same way as they have been considered in recent years. In England, C. Spence Bate exploited a similar idea in 1886, under the term "lateral compression." In Europe, Karoly, in 1901, introduced traumatic occlusion to the profession as a principal etiological factor. In a paper in 1917, Paul R. Stillman introduced abnormal pressures on the bone and pericementum, due to malocclusions, as the predominant cause of pericementitis. These conditions he denoted as *traumatic occlusion*. The idea was rapidly adopted by many of the profession, and no phase of the etiology of pericementitis has been more discussed in the last twenty years.

Although the theory of traumatic occlusion has attracted many adherents, it has also met considerable opposition. In some instances, although function has been regarded as a factor in the production of pericementitis, under-function rather than over-function has been held to be the cause. In other instances, an attempt has been made to demonstrate that the traumatic occlusion is a result and not a cause of the periodontal disease.

Kronfeld, 1931, maintained that the reaction of the pericemental tissues in function depends largely upon the tone of the tissues themselves. In "well-reacting" cases, according to his view, overstress produces hypertrophy of the periodontal membrane and

consequent greater capacity for supporting excessive pressures; lack of function results in atrophy of the peridental membrane.

MICRO-ORGANISMS. Interest in the part played by micro-organisms in pericementitis was greatly enhanced at the beginning of the new century. Competent bacteriologists began a search for a specific organism to which the origin of the disease might be attributed. At the same time there was a tendency on the part of many dental pathologists to emphasize other factors as primary causes, and to assign to bacteria merely a secondary part. Study of the relations of bacteria to inflammation and suppuration, which had begun in the eighties, led to the belief that a participation by micro-organisms did not involve their constituting a specific cause, nor imply a transmittable infection. The experience of G. V. Black must have been like that of many other of the earliest adherents of the bacterial theory. As early as 1887, Black recognized the difference between specific and low-grade pathogenic bacteria, and began interpreting dental pathological processes as low-grade infections. The conclusions of the many investigators with regard to the etiological significance of the numerous micro-organisms discovered in association with pericementitis, have been so at variance with each other as to give very little support to a theory of the specificity of the infection.

Various diseases of the mouth have been ascribed to spirochetes, including noma and Vincent's stomatitis, by Tunnicliff in 1905-1911. Bacteria that have been thought responsible for pericementitis are the various cocci; for example, the micrococcus catarrhalis by Goadby in 1905, the pneumococcus by Medalia in 1912, and diplo-streptococcus by Hoxie in 1915.

In 1914, M. T. Barrett and Allen J. Smith reported that an ameba, the *endamoeba buccalis*, was an etiologic factor in pericementitis. Simultaneously Chiavara, before the American Dental Society of Europe, presented an important study, in which he concluded, among other things, that the "entamoeba is found in the pus of all cases of pyorrhea alveolaris"; and "has not a pathogenic action; on the contrary, as it feeds on bacteria, it is most probably an aid to the auto-disinfection of the mouth." Barrett and Smith's conclusions at this time, however, were that "These organisms . . . do possess a real pathogenic influence."

In the following year Bass and Johns reported on similar work in connection with amebas in pericementitis, which they had begun independently of Barrett and Smith. Their conclusions suffered considerable immediate criticism, as being far more positive than the evidence offered would warrant.

EFFECT OF SYSTEMIC CONDITIONS. Since 1896, attempts to find a systemic factor in the etiology of pericementitis have been largely directed toward fundamental inherent conditions in the tissues involved; and these attempts have been, for the most part, based upon interpretations of the histo-pathological material studied. Thomas Bell in 1829, said: "It is necessary to recollect that the

teeth are removed in old age by this identical mode, namely, the destruction of their support by the absorption of the gums and alveolar process."

Somewhat similarly, but with more elaboration, Talbot, 1896, argued that since the structures were transitory, they would be more sensitive to untoward influences, and when injured, would be less likely to recover or to be restored. The local causes which were commonly regarded as bringing about pericementitis were all admitted by Talbot with the exception of micro-organisms, which he regarded as always secondary. The systemic causes might be any condition of the body which would bring about an irritation leading to inflammation; and the alveolar structures would be first affected because of their transitory nature.

Other systemic influences of a fundamental nature, which have within recent years been regarded as playing a part in the initiation of pericementitis, are hereditary predispositions, metabolic and endocrine disturbances, systemic infections, and allergies. Experimental investigations of the effects of diet have thus far been inconclusive. The effects of the endocrines and of allergies have scarcely been studied.

TREATMENT. From the time that attention was directed to micro-organisms as a possible cause of pericementitis in the eighties, considerable use of antiseptics and specific drugs, aimed at the micro-organisms, was made. The ascription of pericementitis to spirochetes as a cause led to the use of anti-syphilitics in the treatment. Kritschewsky and Séguin employed neosalvarsan, both by injection and by topical application. Cavalié and Mandoul recommended intra-osseous injections. The announcement that amebas caused pericementitis brought with it the introduction of the use of emetin.

Various forms of radiation have been employed to some extent in the treatment of pericementitis, partly with a view to the direct destruction of micro-organisms, and partly with a view to stimulating the tissues to greater reaction.

Practitioners who attempted to deal with micro-organisms assumed to cause pericementitis, found their chief difficulty in that the antiseptic or specific employed either was too weak to have any considerable bactericidal effect when diluted, or when used in greater strength was so injurious to the tissue cells as to prevent their recovery.

VACCINES. Sir Almwroth Edward Wright, in 1900, utilizing the discoveries of Metchnikoff regarding the function of the phagocytes in the blood, and of Buchner with regard to the part played by the blood serum in overcoming infection, brought to light the opsonius, substances in the blood which prepare the bacteria for digestion by the leucocytes. He devised the opsonic index, whereby the power of the blood to destroy micro-organisms could be determined. Kenneth Goadby, in his investigation of micro-organisms

associated with pericementitis, 1901, was already entertaining the possibility of producing a vaccine which might immunize the infected peridental tissues against disease.

Vaccines began to be employed experimentally in America about 1907. The earliest vaccines were all autogenous, but because of technical difficulties in their preparation, stock vaccines were sometimes substituted. The original enthusiasm of the vaccine advocates became somewhat abated by 1915, and criticism of the usefulness of the vaccine method grew stronger. It was beginning to be apparent that the situation in pericementitis was not ideal for the application of immunizing methods.

MECHANICAL PROCEDURES. Those practitioners who believed in functional maladjustments of occlusion, and those who held local injuries to be the cause of pericementitis, largely employed mechanical and operative means to improve physiological demands of the involved tissues in preventive and curative treatment. By means of restoring normal occlusion, grinding cusps, and avoiding restorations that were too high, the believers in traumatic occlusion have attempted to prevent and reduce traumatism. Those who believed in lack of function as a cause have resorted to massage and brushing of the gums. Avoidance of overhanding fillings and poorly adapted crowns, and the restoration of contacts have been given prominence in treatment by those who stress local injuries. A. D. Black, since 1911, has stressed this type of treatment.

GUM RESECTION. The general tendency throughout the earlier periods in America, previous to about 1910, had been to limit treatment to those forms which sought complete restoration to the condition previous to pericementitis. But failure to secure protection of the supporting tissues of the teeth by such operative means, either through neglect by the patient or the dentist, during the period of gingivitis or the early stages of pericementitis, have been considered as necessitating more radical measures. Within late years, consequently, the resection of the gum has come into prominence. This operation was performed more than one hundred and fifty years ago, and has been more or less generally advocated and practiced since that time. The earliest account of the technic was given by Bourdet in 1757. In case cautery failed to produce a cure, Bourdet made a V-shaped incision from the sides of the tooth to the bottom of the pocket. Another Frenchman who employed this operation early (1823) was Toirac. It was also mentioned favorably by early English and American practitioners, including Woolfendale, 1783; Longbotham, 1802, and Horace Hayden, 1822. L. C. Ingersoll wrote in 1877: "My method is to remove with scissors the apices of the gum in the inter-spaces of the teeth and cauterize the whole gingival margin with carbolic acid. . . . This method is speedy and thorough, and rarely attended with much pain. In worse cases, involving the whole margin of the gum, I have removed with knife and scissors the entire marginal border in one strip from the second bicuspid on the left around to the correspond-

ing tooth on the right, and have witnessed the most decided beneficial results in two or three days time."

A revival of this operation took place in the second decade of the new century. Pickerill, in his *Stomatology in General Practice*, 1912, described the operation and applied the term gingivectomy to it. G. V. Black also described and advocated the operation in his *Special Dental Pathology*, 1915. From that time on gum resection has been generally employed, although opposed by many operators who have believed that pericementitis was curable, even in advanced cases, and who have relied upon scaling methods to accomplish this cure. The advocacy of gum resection by A. D. Black has apparently done much to establish the vogue of this operation since 1915.

Although the commonest form of gum resection in America has always been the simple removal of the tissue forming the pocket, another form, the flap operation, since its introduction in 1918 by Zentler, has been practiced. This operation was probably first employed in Europe by Cieszynski in 1914, and brought into vogue largely by Widman in 1917, and Neumann in 1920. Some modifications, such as Kirkland's, have later been employed.

SYSTEMIC TREATMENT. Assumed systemic causes of pericementitis have been treated more or less experimentally within recent years by appropriate remedies. Where the cause has been supposed to be dietary, the deficiencies in mineral salts or accessory food factors have been supplied by administration of calcium lactate, etc., or of vitamins, as in the case of orange juice. When the disease was assumed to be due to glandular disturbances, endocrine extracts have been given. No conclusive results have as yet been demonstrated.

RESULTS OF TREATMENT. The results of the various treatments, and more especially the possible results of any treatment, have been the most debated questions throughout the history of pericementitis. The incidence of curable cases has been placed all the way from zero to one hundred per cent. Some have contended that the most that could be hoped for from treatment was to retard the disease and put off the ultimate loss of the teeth. The principal point at issue has been whether or not the destroyed tissues could be regenerated, and especially whether the periodontal membrane could be induced to reattach to the cementum.

As early as 1783, Wooffendale declared, "Before I close my observations on the dropping out of the teeth from the scurvy of the gums, I must again repeat, that when the smallest part of the roots of the teeth are exposed, in consequence of the adhesion of tartar on them by the scurvy in the gums, venereal infection, or the imprudent use of mercury, I never saw the least disposition in the gums to grow to the teeth, although assisted by *scarification*; or by *stimulating, balsamic, astringent*, or any other sort of washes

or *applications*: the gum would as soon grow to a piece of *ivory* or *iron*, as to the root of a tooth which had lost its periosteum from any of the causes here alluded to. When the exposure of the roots of the teeth is occasioned by accident, as a bruise, a cut, or the like, it will frequently be readily restored by nature, generally without the assistance of art."

Longbotham, 1802, however, speaks of treatment "when the gum is to be made to re-adhere, which can only be when the physician has completed his part, and is done by removing the edges refusing to adhere, and creating a re-birth of gum, which seldom fails to attach itself."

Difference of opinion on this point has continued uninterrupted to the present day. G. V. Black came to regard all suppurative detachments of the peridental membrane as permanent detachments. He believed that the cementum was transformed into practically a foreign body, and therefore the negative chemotaxis that existed between it and any vital peridental membrane fibers prevented any possibility of a reattachment.

On the other hand, in support of the claim of reattachment, Box and McCall have cited a case operated on by the latter in 1912, and examined microscopically eight years later by Box, when the tooth and surrounding tissues were removed surgically in 1920. It was claimed that the sections made from this specimen showed beyond doubt a reattachment of the connective tissues to the cementum surface. Gottlieb examined these claims, and declared, "Unfortunately, McCall and Box did not ascertain the depth of the pocket with absolute objective accuracy. The absence of Sharpey's fibers, cementoblasts and epithelial rests, and the fact that the connective tissue fibers run parallel to the cementum surface, are not sufficient proof that the bottom of the pocket was originally somewhere between the middle third and the cervical third, and was raised to the level of the amelo-cemental junction after treatment. Whether or not any change has taken place can only be found out by taking very accurate measurements of the pockets before and after treatment, or else by measuring the relationship between the pockets and the tip of the crown. I am, therefore, rather skeptical as to whether we may accept the above authors' hopes of regarding pyorrhea as a curable disease where the bottom of the pathological pockets may be brought up to the 'normal level at the amelo-cemental junction' by appropriate conservative treatment."

In general, Gottlieb was of the opinion "that the reattachment of the tissues, constituting the pocket walls, to the tooth surface is possible, but must be regarded rather the exception than the rule. To endeavor to move the pocket bottom to the level of the amelo-cemental junction, and to regard this as the aim of a successful treatment is unjustified. If we hope for a successful reattachment at all, the scraping out of both pocket walls is a fundamental condition. We have no control over the actual healing process."

Gingivitis and Pericementitis Due to Deposits of Salivary Calculus

BIBLIOGRAPHY ON INVESTING TISSUES PAGE 265

ILLUSTRATIONS: FIGURES 1302-1345.

SALIVARY calculus is the term applied to the calculus which enters the mouth with the saliva, and becomes deposited upon the teeth, plates, or other hard substances within the mouth. The word salivary is used to distinguish this deposit from the calculus which may be deposited in the gall bladder, urinary bladder and elsewhere. Since other calculi found in the body are very closely related, the gall bladder calculi being formed of cholestrum instead of calcium salts, and since the underlying causes of all are probably similar, the investigations here presented apply in large measure to all of the various forms of calculi. There is little question to doubt but that the elements necessary to the formation of the deposit in all the various places in which it may occur are present in all simultaneously and lack only the local nidus which is necessary to a beginning accumulation.

Not infrequently calculus is found on bullets and other metallic substances lodged in the flesh, which have remained for some time. This calculus, particularly on lead, seems to be softer than the calculus formed in the saliva or in the urinary bladder, yet there can be no doubt whatever of its character. This shows plainly that calculus may also be deposited from serum exuding from the tissues, and is therefore carried by the blood stream.

In view of the fact that calculi in other parts of the body oftentimes call for surgical interference, and since the deposits occurring in the mouth are conveniently located for study, the dental research worker has the opportunity to develop knowledge in this field, particularly in relation to the prevention of the deposits, which should be of great value. Considerable evidence has been gathered which indicates that the diet, or possibly the amount of food assimilated, is in part at least responsible for the occurrence of the deposit. Studies which would discover ways of preventing deposits on the teeth other than by artificial cleaning, should be effective in preventing the formation of calculi in the kidney, gall bladder and elsewhere in the body.

Figures 1302 and 1303 are photographs of salivary calculi removed from the ducts of the salivary glands. 1304 is a radiograph of a large mass of calculus in Wharton's duct. It should be noted that all of these deposits occurred from the saliva before

it reached the mouth. Conditions in connection with accumulations elsewhere in the body are similar.

The deposit does not occur in every mouth. In some mouths, there will be an occasional deposit, with long periods during which there is none. In others the deposit seems to be occurring all the time. Generally children and young people are freer from deposits of calculus than adults. Quite a number of cases occur in which persons have no deposits until they are forty, fifty or even sixty years old, and afterward are much troubled with it.

COMPOSITION. Salivary calculus is composed of calcium phosphate, with the addition of smaller amounts of calcium carbonate, held together in mass by an organic compound which, according to general opinion, is formed after the material has been deposited upon the teeth, natural or artificial. The fresh deposit is very soft and greasy to the feel of the fingers, insoluble in water, and in alcohol.

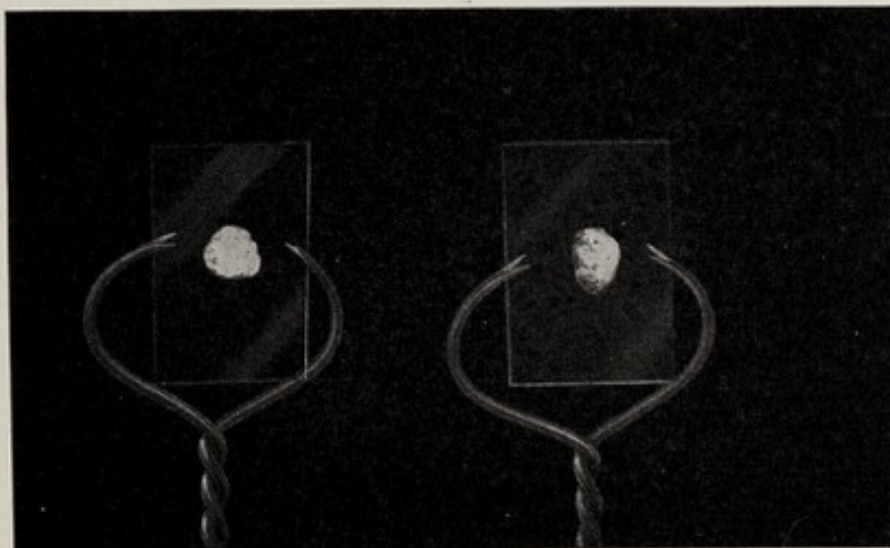


FIG. 1302.

FIG. 1303.

FIGS. 1302 and 1303. Reproductions of salivary calculi removed from ducts of salivary glands. Actual sizes.

ANALYSIS. In the text-books, a number of analyses of salivary calculus have been published. These differ considerably. A part of these differences are due to variations in the amount of water and mucus, and the fact that a number of them combine water and organic substances in their report. One may analyze calculus fresh from the mouth, after drying it upon blotting paper. Another may have analyzed calculus that was old and thoroughly dry. Unless these conditions are stated, the amount of water will vitiate the figures of the analysis. An analysis by Schehevetskey* gives as good an idea of its composition as can be obtained from these anal-

* Journal of the American Medical Association, Vol. 71, p. 1179. Noyes' Histology, Fourth Edition, p. 191.

yses. Such reports would naturally vary, for calculus seems not to be a strict chemical compound of invariable composition.

Water and organic matter.....	22.07
Magnesium Phosphate	1.07
Calcium Phosphate	67.18
Calcium Carbonate	8.13
Calcium Fluoride	1.55
	<hr/>
	100.00

In a number of the analyses no magnesium phosphate is reported; in some a little calcium fluoride is reported.

STUDIES OF DEPOSIT OF SALIVARY CALCULUS.

Considering the length of time in which the deposit of salivary calculus and the great injury it has done to mankind have been observed, the history of the study of it in the literature is very disappointing. All, or nearly all, have agreed upon certain points

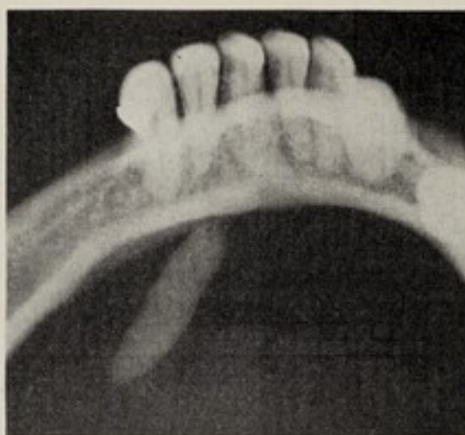


FIG. 1304. Radiograph of calculus in Wharton's duct.

and there the subject has been dropped. The essential facts in the writings of many men may be covered in a few sentences.

The points on which most investigators have agreed have been these: Calculus is composed mostly of calcium salts which are precipitated from the saliva. These salts find lodgment and settle in out-of-the-way places about the teeth, and become aggregated by entanglement in partly inspissated mucus or other colloids from the saliva. In these positions the material settles into more compact form, as the colloid material is slowly decomposed, and hardens into stone-like masses. These masses grow by more or less constant additions upon the hardened or hardening material, until, sometimes, quite large and thick masses of it are formed. These masses are in close approximation to the soft tissue investments of the teeth, and cause them to become inflamed and to be destroyed partly by resorption and partly by suppuration, resulting in the loosening and final loss of the teeth.

BURCHARD'S STUDIES. The first study of consequence relative to the occurrence of deposits of calculus in the mouth was by

Dr. Henry H. Burchard* on "The Origin of Salivary Calculus" in 1895, published in his book in 1898. He believed that an excess of calcium phosphate was held in solution in the saliva within the salivary glands as a result of the presence of carbon dioxide, and was precipitated when the saliva entered the mouth and the carbon dioxide was liberated; also that lactic acid acted on mucous in the mouth to form a curd in which the salts became entangled and were held while they hardened.

G. V. BLACK'S INVESTIGATIONS†.

Studies of deposits of calculus were carried on over a period of about five years, beginning in 1906. A very brief summary of these investigations is presented.

In order to study the conditions under which deposits occurred, a small gold frame was made and fastened with two gold screws to the buccal wing of an upper denture. A rectangular microscopic

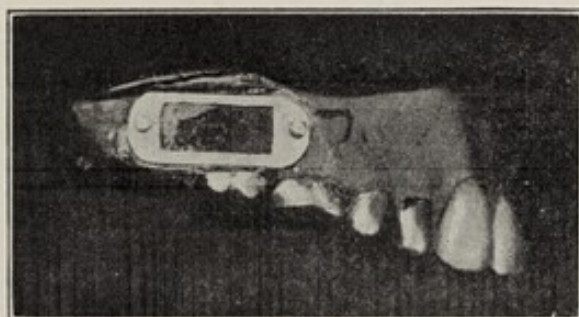


FIG. 1305. A device attached to a vulcanite upper denture, used for the collection of deposits of salivary calculus.

cover glass, placed under the frame was held in position and could be removed for the study of whatever deposit had occurred. A single glass could be left in position for as brief or as long a time as desired, thus permitting one to time the occurrence of deposits, also the various stages of the hardening process could be studied. See Figure 1305. Specimens were stained for microscopic study for comparison with sections of hard deposits, which were prepared by the use of a special grinding machine, ** designed and built for the purpose of grinding microscopic specimens of friable or other hard substances, such as calculus, teeth, etc.

The following were selected as the observations which appear to be of practical value today:

NOMENCLATURE. The term *calco-globulin* was applied to the mass of soft material, containing calcium salts, which may be deposited on the teeth, or other hard substances in the mouth, and gradually become hard as the softer material is decomposed.

* Dental Cosmos, Vol. 37, 1895, p. 821. Dental Pathology and Therapeutics, 1898, p. 447.

† Items of Interest, Vol. 33, 1911, p. 420. Dental Review Vol. 26, 1912, p. 337.

** Described and illustrated in Black's Special Dental Pathology, p. 460.

The term *agglutinin*, or *agglutinin of calculus*, was applied to the protied material which serves to hold the calcium salts together during the hardening process.

NIDUS NECESSARY FOR BEGINNING DEPOSIT. The deposits invariably began in the little angle formed by the meeting of the edge of the gold frame and the cover glass. This corresponded with the clinical observation that the beginning deposit always occurs in some depression or irregularity which is somewhat protected from the friction of food, the movements of tongue, cheeks, etc. In one case, the line of junction of the gold frame with the glass was polished to the thinnest possible edge and no deposit could be collected on the glass until the margin of the gold was slightly roughened.

MICROSCOPIC APPEARANCE. The deposit appears to be made up of several kinds of minute spherules, differing chemically, as in-

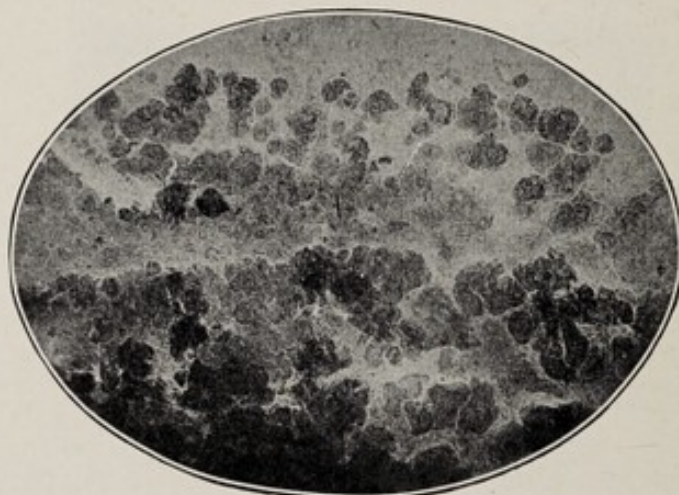


FIG. 1307. Agglutinin of salivary calculus showing irregular spherules laid down on cover-glasses worn in the mouth.

indicated by the several stains used. These are combined into larger masses in irregular rounded forms. See Figures 1307 and 1308.

PAROXYSMAL CHARACTER. The occurrence of the deposit is paroxysmal in character. This was so with a number of persons whose reactions were studied, all of whom were in good health. Any of these persons who ate heartily of palatable meals, which were apparently well digested, would have a heavy deposit of calco-globulin within the next few hours after the meal. The deposit shown on the denture in Figure 1309 was laid down in a single paroxysm. A number of persons who had been subject to deposits were entirely free from accumulations for periods of several weeks, or so long as they ate sparingly, yet a deposit could be induced by a single heavy meal. If a laxative were given shortly after a heavy meal, no deposit of calculus occurred. Several were students who

‡ See frontispiece, Vol. III of this work.

discovered during the course of the experiments that they were able to study longer in the evening without becoming sleepy, during the periods when they were on the lighter diet.

SALIVA COLLECTED FROM STENSON'S DUCT. A special tube was made to collect saliva directly from Stenson's duct, with the result that deposits of calco-globulin occurred on a cover glass suspended near the bottom of a test tube, into which the saliva flowed.

QUANTITY OF FOOD DIGESTED SEEMED TO CAUSE THE DEPOSIT. No determination was reached as to the possibility that certain foods might be responsible for the deposit. So far as any evidence on this point was developed, it suggested that the quantity of food digested, rather than any particular food, caused the deposit.

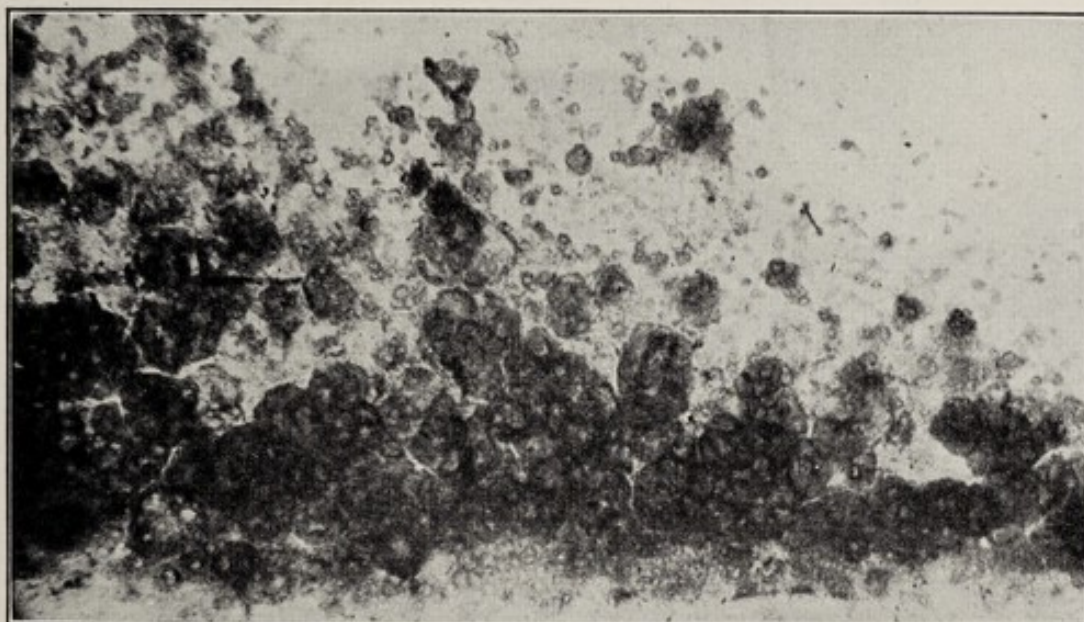


FIG. 1308. Appearance of a rapid deposit (about four hours), stained by nigrosin. Many of the primary spherules refuse the stain, which gives a lobulated appearance.

PREVENTION OF DEPOSITS ON THE TEETH. One of the most important observations was that freshly deposited agglutinin of calculus could be readily removed by holding the denture on which the deposit occurred under the running water from a faucet. The deposit of calculus can be removed with a tooth brush and water at any time within about twenty-four hours after it is deposited, and may be removed after forty-eight hours by vigorous brushing with a fairly stiff brush. There is no question but that the accumulations of the deposit can be prevented by proper twice daily brushing of the regions where the deposit occurs.

In persons in chronic ill health, and especially those whose condition is that of marked malnutrition, an almost constant slow deposit of agglutinin seems to occur. This may not carry with it any deposit of calcium salts. In that case it does not harden as do

other deposits, but settles into a curd-like mass which strongly resists removal with the brush, but may readily be scraped away. This form of deposit never becomes very hard. The material, however, gives the same appearance in stained specimens as that containing calcium salts. This form of deposit of agglutinin sometimes creates a very foul condition of the plate and mouth through the putrefactive decomposition which occurs in the mass. A low grade of inflammation of the soft tissues occurs wherever this decomposing material is in contact with them.

The report of these studies concluded with the following statement:

"I am slowly, by each successive step, being driven to the conclusion that the thought of a precipitate of calcium salts from the saliva so long held, by myself and others, has been a myth. It seems now that calculus comes into the mouth as a finely divided calco-globulin which collects in masses on hard substances and is finally, with the decomposition of much of the colloid elements, hardened into stony calculus."

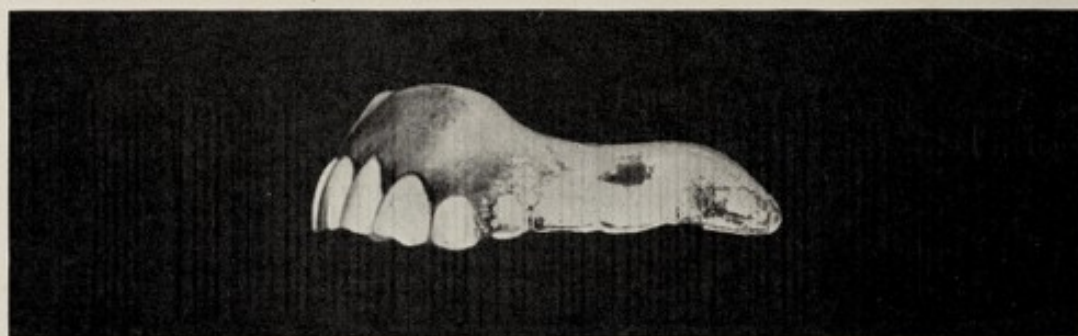


FIG. 1309. A denture showing a deposit laid down in a single paroxysm.

Diagnosis of Injuries to Tissues

The injurious effect of the deposit of salivary calculus upon the teeth has been known since the earliest historical times. It has always been regarded as a deposit from the saliva. The calculus is deposited upon the teeth, never upon the mucous membranes or other soft parts. It is, however, the soft tissues which are injured—not the teeth themselves, except as they lose their soft tissue and bony investment. Being deposited upon the teeth, the calculus, having become hard, impinges upon the soft tissues and causes them to become inflamed and red, to bleed easily, and to become involved in suppurative processes.

The place of first deposit of salivary calculus is on the *exposed surfaces of the enamel* in contact with the margins of the gingivæ, most frequently on the lingual surfaces of the lower incisors, or the buccal surfaces of the upper molars. The initial deposit appears as a thin yellowish-white line on the enamel along the margins of

the gingivæ. The crests of the gingivæ become inflamed and slightly blunted and the normally thin edge is gradually replaced with the deposit. As the process continues, more and more of the gingivæ is destroyed and replaced by additional deposit. As the deposit increases, the gingivæ become thickened and shortened very slowly. The greater thickness of the tissue gives a broader shelf for the lodgment of more calculus. Each addition to the deposit occurs more or less in layers, between the inflamed soft tissue and the calculus previously deposited. This process may gradually



FIG. 1312.



FIG. 1313.

FIG. 1312 shows a slight deposit on the lingual surface of a lower incisor which has caused a gingivitis only.

FIG. 1313 shows a similar slight deposit on the buccal surface of an upper molar.

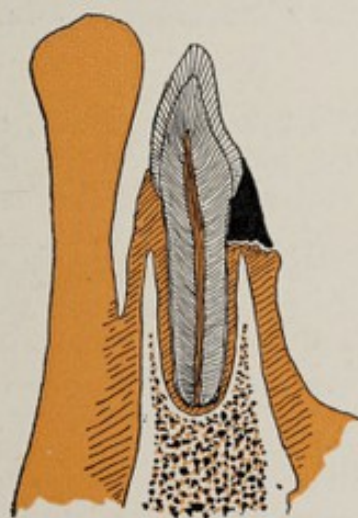


FIG. 1314.



FIG. 1315.

FIG. 1314 shows a more extensive accumulation on the lingual of a lower incisor.

FIG. 1315 shows a still greater destruction, including also the labial tissues. It will be noticed that all of the investing tissues—gingivæ, periodontal membrane, bone and gum—are destroyed on a line practically horizontal to the long axis of the root.

destroy all of the gingivæ to the cemental line, and then continue, destroying and replacing with additional calculus, the body of the gingivæ attached to the cementum and subsequently the peridental membrane, alveolar process and gum tissue. See Figures 1312 to 1315.

The deposit of calculus tends to spread in all directions on the surfaces of the teeth that are not kept clean by the rubbing of food over them in mastication, or by the movements of the tongue, or by artificial cleaning. As a result the deposit very commonly replaces in form the tissue which is progressively destroyed. In occasional cases, the deposit will be thicker than the thickness of the gingivæ, and will overlap the lingual or labial surface of this tissue. This is most frequently seen to the lingual of the lower incisors, but may occur to the buccal of the molars, or elsewhere. The soft tissue will often remain intact for a considerable time under this overlapping calculus. See Figures 1316, 1317 and 1318.



FIG. 1316.

FIG. 1317.

FIG. 1318.

FIGS. 1316, 1317, 1318. Lower incisor and cuspids with deposits of salivary calculus which overlapped the gum tissue.

SUPPURATION. The irritation of the investing tissue, caused by the presence of the deposit, and the covering of the deposit itself, offer opportunity for collection and growth of the bacteria of the mouth. Therefore, suppuration of the soft tissue, in contact with the deposit, occurs from time to time, destroying parts of the tissue, and this gives opportunity for the deposit of more calculus in the space gained. This goes on, very slowly as the rule, until the free gingivæ are destroyed and the deeper tissues are reached.

PERICEMENTITIS. If not artificially removed, the encroachment of the calculus extends farther and farther in the apical direction, involving the crest of the alveolar process and the adjacent soft tissue. The inflammatory reaction within the gingivæ is well illustrated in Figures 1319 to 1322. Figure 1319 is a case in which the gingivæ had receded to a position well below the cemental line of the tooth. There is a thin deposit of calculus covered with

some debris, on the cementum. It has destroyed almost the full thickness of the epithelium of the very crest of the gingiva. The inflammation in the connective tissue immediately below, which extends almost to the crest of the bone, is very clearly shown. The normal projections of connective tissue into the epithelium of the gingiva are also nicely shown in this illustration.

Figure 1320 shows a larger deposit, which is very typical of the accumulations that are commonly removed from the lingual surfaces of the lower incisors of many persons who report to the dentist every six months, but have never formed the habit of brushing these surfaces properly. In the illustration, the concave edge

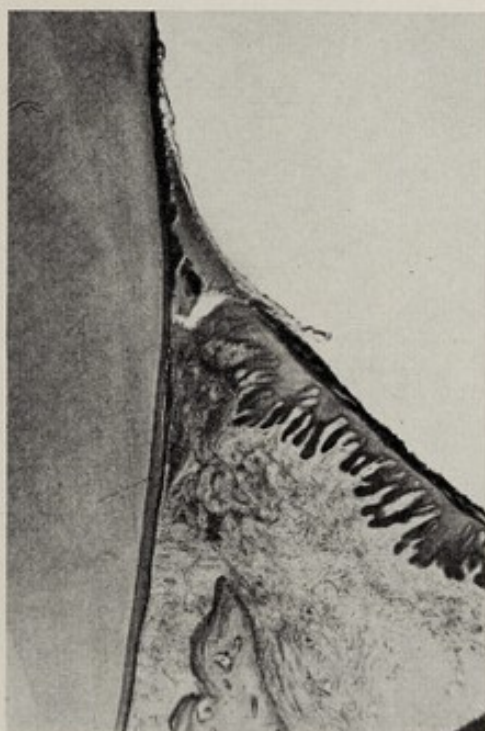


FIG. 1319.

FIG. 1319. Deposit of salivary calculus in case in which the gingiva had previously receded to expose the cementum.



FIG. 1320.

FIG. 1320. Deposit of salivary calculus on the lingual surface of a lower incisor.

of the gingiva should be in contact with the deposit; it separated in preparing the specimen. This also shows an extensive inflammation penetrating the connective tissue. If such a deposit begins to recur within a few days after it is removed, the patient, who presumably has similar deposits on a number of teeth, must have considerable suppuration in progress during four or five months, or longer, until the new accumulation is removed, and this is repeated again and again.

Figure 1321 shows a much heavier deposit than in the previous illustration on the labial surface of a lower incisor. Most of the gingiva and also the bulk of the deposit are out of position in the illustration. The calculus should be in contact with the root, and

the crest of the gingiva should closely approximate the deposit. It will be noted that the deposit has been laid down partly within the gingival crevice. This seldom happens in cases in which there has been no injury to the attachment of the gingival group of fibers to the cementum. The fibers of the peridental membrane which normally hold the gingiva in pressure contact with the enamel are missing in this specimen. Most of the epithelial covering at the crest of the gingivæ and the inner lining has been destroyed. Particular attention is called to the inflammatory reaction which is principally along the routes of the blood vessels and lymphatics.



FIG. 1321.

FIG. 1321. A considerable deposit of salivary calculus on the labial surface of a lower central incisor, which has caused an extensive gingivitis.



FIG. 1322.

FIG. 1322. Inflammation of septal gingiva by deposits of salivary calculus.

Figure 1322 is a longitudinal mesio-distal section through the interproximal space. Deposits of calculus are attached to the cementum of the two roots and the space between the deposits, to the occlusal of the gum tissue, is filled with debris. The clear space is entirely artefact. Most of the epithelial covering of the septal gingiva has been destroyed and the remainder shows extensive round cell infiltration. Resorption of the crest of the bone is in progress. This illustration shows a strong band of trans-septal fibers connecting the two teeth.

On examining the soft tissue immediately after the removal of the calculus, granulation tissue only will be seen. A sharp steel probe will, however, show but a slight covering of granulation

tissue over the shortened and apparently thickened stub of the partly absorbed alveolar process. In this way, the bony alveolar wall is destroyed, little by little, from month to month, as more and more calculus is added, going deeper and deeper along the root of the tooth to which it clings. All of the investing tissue, soft and hard, is destroyed as this progresses.

ATTACHMENT OF PERIDONTAL MEMBRANE TO ROOT MAINTAINED TO LEVEL OF SOFT TISSUE REMAINING. No matter what the extent of the injury, the attachment of the peridental membrane to the root is usually maintained to the level of the soft tissue remain-

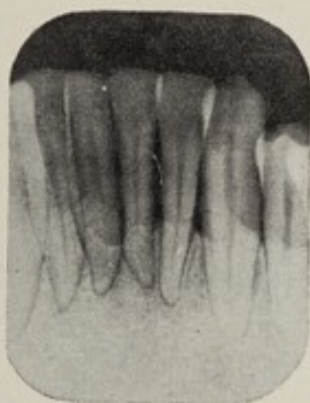


FIG. 1323.



FIG. 1324.

FIGS. 1323 and 1324. Reproductions of radiographs showing extensive destruction of the alveolar process by deposits of salivary calculus.

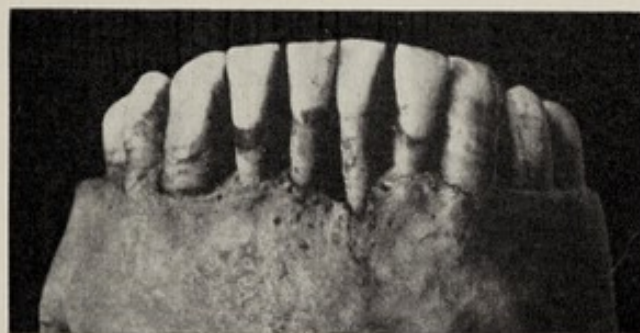


FIG. 1326. Destruction of the bone by deposits of salivary calculus, which is especially deep between the central incisors.

ing. See Figures 1312 to 1315. Any considerable accumulation may be broken away from the tooth with suitable instruments, and give a clear view of the process of destruction. The clean, white tooth crown will stand in the midst of an inflamed, red and bleeding tissue, often showing the cemental line where formerly the soft tissue was attached. In many cases all of the gingivæ will have been destroyed. The rule is that pockets are not formed alongside the roots, although some detachment may occur in the more advanced cases. This is markedly different from the process by which the investing tissues are destroyed in chronic suppurative pericementitis, as will be described later.

Figures 1323, 1324 and 1326 illustrate the destruction of the bone of the alveolar process by deposits of calculus. In both cases for which the radiographs were taken, the incisors were so loose that they were extracted. Figure 1326 shows the destruction of bone, which is usually more extensive on the lingual side of these teeth. Figure 1327 is from a photomicrograph of a section of a deposit attached to the lingual surface of the root of a lower incisor.

PAIN AND SORENESS. During the early progress of this disease there is little or no pain. The teeth may become more or less tender in mastication, and the effective work of the teeth in chewing food, also the cleaning which occurs as a result of vigorous chewing, will be diminished, giving additional opportunity for the accumulation of deposits and a corresponding increase of the inflammation. It is only toward the later stages that the patient will complain of pain in the tissues which support the teeth. This is

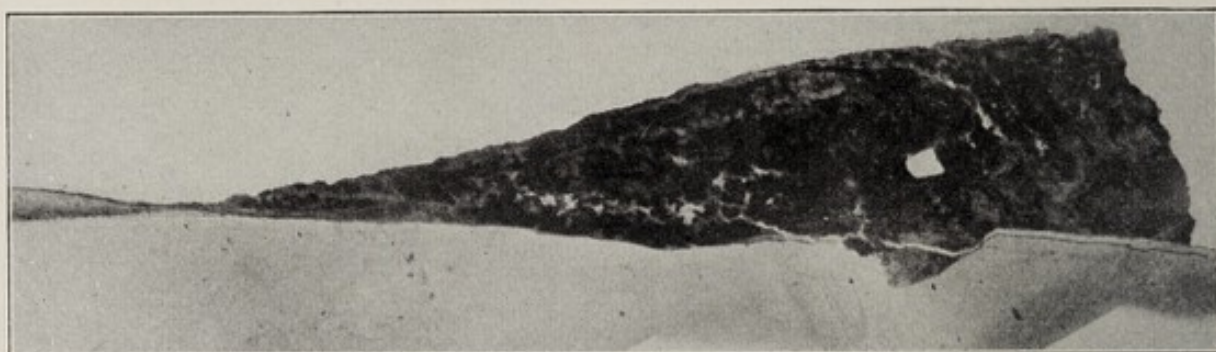


FIG. 1327. Photomicrograph of a ground section of a tooth with a deposit of salivary calculus attached to the root. The gingival portion of the enamel may be seen at the left of the illustration. Something of the lamination of the deposit as it was gradually built may be seen.

generally due to inflammation resulting from the excessive movement of the teeth. Usually this is not of much consequence and passes away in a few days.

CONDITIONS CONTRIBUTING TO OCCURRENCE OF DEPOSIT.

1. The material constituting the deposit must be brought to the mouth by the saliva from the salivary glands.
2. Deposits usually occur first on teeth near the opening of the ducts from the parotid or the submaxillary and sublingual glands. Taking all cases together, these are the places where the bulk of the calculus is deposited.
3. Points of depression in the gingivæ of certain regions or about certain teeth, the thickening of the crests of the gingivæ from any cause, such as mechanical injuries, previous injuries by calculus, etc., may become places of deposit because of the opportunity presented for deposits to accumulate without being disturbed.

FORM WHICH GIVES OPPORTUNITY FOR INITIAL DEPOSIT. The controlling factor then is the form which gives opportunity for

the deposit. When calculus enters the mouth with the saliva it is immediately ready for deposit, and the nearest teeth would most likely receive it. This is the general rule, as has been stated. But the teeth of this locality, and their gingivæ, may be of excellent form, and will not readily receive the deposit, or the soft deposit may be removed in the act of chewing food at the next meal. Then deposits may or may not occur elsewhere, depending upon form which will favor a lodgment.

The position of the deposit is determined by some peculiarity of form which usually will, on close study, be found to furnish a place for the initial deposit and shelter it from removal during mastication. This may be an irregularity in the position or form of the teeth attacked, or of their gingivæ. To produce such a result the deviation from normal form need not be great, but just a slight depression of the crest of the free gingivæ and a thickening of its margin, which will furnish a favorable place for sheltering the deposit. Sometimes the upper molar teeth are strongly inclined



FIG. 1328.

FIG. 1329.

FIG. 1330.

FIG. 1331.

FIGS. 1328, 1329, 1330 and 1331. Teeth of normal form showing extensive deposits of salivary calculus.

buccally, and the buccal margins stand out over the buccal surface of the lower molars. This prevents the rubbing of the buccal surfaces of the upper molars by food in the act of chewing, and makes these surfaces favorable places for lodgments.

VARIATIONS IN POSITION AND PROGRESS OF THE DEPOSIT. The earliest deposit of calculus occurs most frequently on the lingual surfaces of the lower incisors. Somewhat later, a beginning may be made upon the labial surfaces also. Often it occurs that the progress is made mostly upon the lingual and labial surfaces, leaving for a time the septal tissue standing between the teeth almost untouched. Finally the calculus may close in upon the lateral sides of these septi and this tissue will be destroyed. See Figures 1328, 1329, 1330 and 1331. In the bicuspid and molar region, the principal deposit is on the buccal surfaces of the upper molars, yet the lingual may become involved, and subsequently the septal gingivæ may be destroyed. The lower bicuspid and molars are usually less extensively involved than the corresponding upper teeth.

DEPOSIT USUALLY CONFINED TO CERTAIN TEETH. Very generally the deposit will be confined to, or a greater amount of deposit will occur on, some certain teeth. Others will escape for a time, or permanently. These are most likely to be the molars, upper and lower, and the lower incisors, sometimes the one and sometimes the other, or both together. Again, some particular tooth, or teeth, other than the groups named, may be attacked. A similar condition is occasionally seen on artificial dentures. If one side is more convenient to use than the other, the unused side will receive and hold deposits, while these will be prevented from accumulating on the used side.

In the mouths of persons who brush their teeth regularly, deposits will be found only in a few positions which are not properly brushed, due to some technical error or oversight in the manipulation of the brush, or to positions of the teeth which make it difficult or impossible to reach the regions where the deposits occur. When the lower incisors are inclined lingually, for example, it may be impossible to reach the lingual surfaces with a brush of standard form.



FIG. 1332.

FIG. 1333.

FIGS. 1332, 1333. An upper and a lower plate with very heavy deposits of salivary calculus. On each of these the greatest thickness of the accumulation is about half an inch.

IN NEGLECTED CASES, TEETH BECOME LOOSE AND ARE FINALLY LOST. As the alveolar process is destroyed the teeth begin to have considerable motion in the remaining part of their alveoli. This loosening may occur when the bony alveoli are but little more than half destroyed. This is effected by the resorption of that part of the bone next to the periodontal membrane, and the lengthening and softening of the fibers connecting the teeth with the bone. The fibers are no longer stretched tightly between the cementum and the portion of bony alveolar walls that are left. The teeth then become very loose and may easily be moved about; yet in an attempt to extract them, they are very firmly held by the elongated fibers of the periodontal membrane, and resist actual removal. Finally, however, the remaining attachment is so slight that at some time, when a very loose tooth is particularly sore and troublesome, the person may succeed in picking it out with his fingers. In this long and tedious way, running from five to thirty years or

more, the teeth are loosened and one by one are lost, until finally the person is toothless.

FORMS OF ARTIFICIAL DENTURES TO AVOID DEPOSITS. This condition suggests the value of a study of the forms of artificial dentures with respect to deposits of calculus. It is quite possible to so make and finish a denture upon which calculus will not be likely to adhere. This requires, first, that all irregularities of surface be avoided; and second, that every part of the denture be finely polished. Every part must be given as nearly a regular smooth surface as is possible. All of the embrasures between the curves of the teeth, as these spread from the contact points, should be filled with gingivæ practically as full as these are in the best natural forms. The crests of the gingivæ should be reduced to a fine knife edge where the vulcanite or other denture material overlaps the teeth. This will make a surface so smooth that no calculus will be deposited upon it. To keep it so in general usage

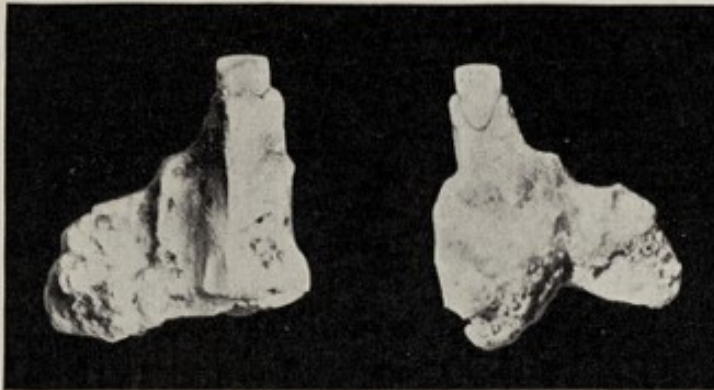


FIG. 1334.

FIG. 1335.

FIGS. 1334, 1335. Labial and lingual views of a lower incisor tooth entirely enveloped, except portion of crown, by deposit of salivary calculus.

may require occasional repolishing. A full upper denture is shown in Figure 1332, and a partial denture in Figure 1333, both of which have very large deposits.

INFLUENCE OF MASTICATION IN PREVENTING DEPOSITS. Occasionally, the influence of the chewing of food in preventing lodgments is strongly accentuated in cases in which chewing is painful. A case was observed of a boy of fourteen, in a juvenile home, whose teeth and gums on the right side were in perfect condition as to cleanliness; they were free from deposits and the gingivæ represented the ideal of health. On the left side, there were heavy deposits which almost completely covered the buccal and lingual surfaces and filled the depressions in the occlusal surfaces. The gingivæ were much inflamed. There was a mesial cavity in the upper first molar and the occlusal enamel had broken away, so that it was painful to chew on that side. The boy had preferred to use only the right side for mastication rather than go to a

dentist. This was a striking case, illustrating the great value of vigorous mastication in maintaining the cleanliness and health of the mouth. The boy had never used a toothbrush.

Some very rare examples of deposits which occurred in neglected cases are illustrated in Figures 1334 to 1339. The deposit on the lower incisor, of which labial and lingual views are presented in Figures 1334 and 1335, extended certainly one-fourth of an inch beyond the apex of the root, and in a large mass to the lingual of several neighboring teeth. In the case illustrated in Figures 1336



FIG. 1336.

FIG. 1337.

FIGS. 1336, 1337. Labial and lingual views of four lower incisors the roots of which are enveloped by deposits of salivary calculus.



FIG. 1338.

FIG. 1339.

FIGS. 1338, 1339. Two views of an upper first molar with an enormous deposit of salivary calculus attached.

and 1337, all four incisors are completely encased in calculus so that the tissue attachment had been entirely severed. There are, in fact, four separate pieces of calculus, one about each tooth, resulting from the fact that each tooth, with the attached deposit, had slight independent movement. However, the irregular forms so fitted into each other, as well as into a trough in the gum, that the patient could remove and replace the four units together at any time, as though they were a removable bridge. Figures 1338 and 1339 illustrate extreme deposits on upper molars.

MENACE TO GENERAL HEALTH. The mass of decomposing pus and food debris in and about the deposits of salivary calculus may present a considerable menace to the general health. This may be the most serious phase of the condition, although it has generally received little consideration, either by patient, dentist or physician. The relation of mouth infections to general systemic conditions is considered elsewhere.

Treatment of Gingivitis and Pericementitis Caused by Deposits of Salivary Calculus

PREVENTIVE TREATMENT. The only known means of definitely preventing deposits of salivary calculus is by proper brushing at sufficiently frequent intervals. Fortunately, in practically all cases in which the gingivæ are in approximately their normal form, the deposit of calculus occurs on buccal, labial and lingual surfaces, which are generally of easy access with the tooth brush.

It has been demonstrated beyond question that twice daily brushing of the surfaces of the teeth on which deposits occur will remove the deposit while it is soft. The prevention of deposits and of the serious damage which these cause, is the responsibility of the dentist and dental hygienist. All children should be trained in the brushing of the gingivæ as a matter of stimulating the circulation in these tissues. They should also be trained in the brushing of the lingual surfaces of all of the teeth and very especially the lingual surfaces of the lower incisors and cuspids.

Many persons brush the buccal and labial surfaces, *excepting the gingival third positions*. They avoid brushing the gingivæ. If a proper brushing technic is followed, deposits of calculus should be found on buccal surfaces only occasionally, due to some irregularity of form.

If the gingivæ are blunted, the movement of the brush from the gum in the occlusal direction will not suffice to prevent either gingival third decays or deposits of calculus. In such cases, the brushing should be done with a mesio-distal motion, with about half the width of the brush on the gingivæ and half on the gingival areas of the teeth.

Many children are not trained to brush the lingual surfaces of the lower anterior teeth, presumably for the reason that they almost never decay. Their brushing habit therefore does not include this region, so that a few years later when deposits occur it is very difficult to interest them in a new brushing effort.

Dentists must realize that they are generally playing a losing game in their effort to prevent the injuries caused by deposits of salivary calculus unless they take seriously the problem of training each patient in the special brushing technic required, and then check up on him at frequent intervals until it becomes a part of his habitual brushing program. This means that a record should

be made of the position of each deposit; the patient should be shown how to brush each region and should be told that an appointment card will be sent to him in a certain time for a check up on his home care.

The best plan is to include the brushing of all gingival third areas in the training of each child so that it becomes a part of the habitual routine. The mouth hygiene technic is given in Volume II, page 12.

TREATMENT BY THE DENTIST.

The treatment of inflammations caused by deposits of salivary calculus should consist: first, of the thorough removal of the deposits and the care of the tissues by the dentist until the inflammation has subsided; second, the training of the patient in the means of preventing a redeposit, gradually leaving to the patient the principal care of the case; third, subsequent examinations at stated intervals to criticize the care by the patient and remove any deposits which may have occurred. It has been sufficiently demonstrated that this plan of treatment is dependable.

The removal of salivary calculus seems to have been regarded as a thankless and disagreeable operation from far back in the history of dentistry. This has been from two causes. First, dentists have had no confidence in the real efficacy of the operation for more than a very temporary benefit; second, the practicability of preventing a recurrence of the deposit by proper brushing was not sufficiently well established. The danger of the eventual loss of the teeth if the patient fails to do his part, has not been sufficiently stressed. There has generally been no detailed instruction as to how or when to clean the teeth, further than to direct that the brush be used. Under these conditions it is no wonder that patients have not succeeded in preventing deposits. The real difficulty is to convince the patient that he can, by proper brushing, prevent the accumulation of the deposit in harmful quantities.

REMOVAL OF DEPOSITS. The instrumental removal of the ordinary deposits of hardened salivary calculus, when taken in time, offers very few difficulties. The deposit is always in sight; if not directly, it may be seen indirectly with the aid of the mouth-mirror. It is practically never buried under the soft tissues, nor covered up. In a very few cases the inflamed gingivæ may slightly overlap deposit. Such cases are much too rare to enter into any calculation for general cleaning processes. However, their possible existence should not be overlooked.

The deposit destroys all of the overlying tissue at right angles to the long axis of the tooth and takes the form and contour of the tissue which it destroys. The fibers of the peridental membrane are not destroyed in advance of the overlying tissues, consequently pockets are seldom caused by deposits of salivary calculus.

Previous to the removal of the deposits, and as a part of the examination of the mouth, a careful record should be made of each

surface of each tooth upon which a deposit is found. A simple and exact method of doing this is presented in Volume I, page 71, in the chapter on Recording Mouth Examinations. This record should be the foundation upon which the future conduct of the case should rest. A definite record of the condition of the mouth as to deposits should be the guide for the after care, the training required by the patient and the frequency of subsequent examinations. It is of the greatest importance that the patient shall in the beginning be impressed, not only with the serious final results of neglect, but with the fact that there is a definite and dependable system of handling such cases.

Figure 1342 is a photograph of a mouth of a patient 35 years of age, which had been neglected. The gingivæ were swollen, of a dark cherry red color, and there were deposits of both salivary and serumal calculus and debris of all kinds possible in the mouth, accompanied by acute inflammatory reaction, with a little discharge of pus. There was, however, very little detachment of the



FIG. 1342.

FIG. 1342. A case of extensive gingivitis caused by deposits of both salivary and serumal calculus and food debris.



FIG. 1343.

FIG. 1343. The same case a few days after the removal of the deposits and the cleaning of the teeth.

peridental membrane from the cementum. Another photograph, Figure 1343, was taken a few days after the deposits had been removed and the teeth had been polished. The inflammation and swelling had disappeared, the tissues were of normal color, with slight recession about several teeth.

The most important service in this case was that of gaining the patient's interest in the care of his own mouth. It is quite apparent that the care of this mouth by the dentist every few months would, in the long run, be of little value if the patient did not cooperate.

INSTRUMENTS AND INSTRUMENTATION. There is no more simple operation in the dentist's field than the removal of deposits of salivary calculus. A limited number of scalers is sufficient. Years ago these instruments were generally much larger and stronger than those of to-day, because of the frequent necessity of removing heavy deposits. It was not uncommon for the dentist to use a

large chisel, held with the edge against the deposit, while the assistant struck it a sharp blow with the mallet. As patients have learned to in large measure prevent the deposit by brushing, the sizes of the scalers used for its removal have become gradually smaller.

A set of six scalers is illustrated in Figure 1344. These consist of one pair of pull instruments, one pair of push instruments, a sickle and a cleoid. These are all that are necessary for the removal of the bulk of the deposits. Their use should be followed by selected instruments from the set of scalers for the removal of serual deposits, which are smaller and are better for removing finer particles which may have been left by the larger instruments. In cases in which the deposit is slight, the smaller scalers will often be preferred to the larger instruments.

The pull scalers should usually be used first for removing the bulk of the deposit from the lingual surfaces of the lower front teeth. These may be followed by the cleoid or sickle, or both, to remove deposits about the angles or on the proximal surfaces.

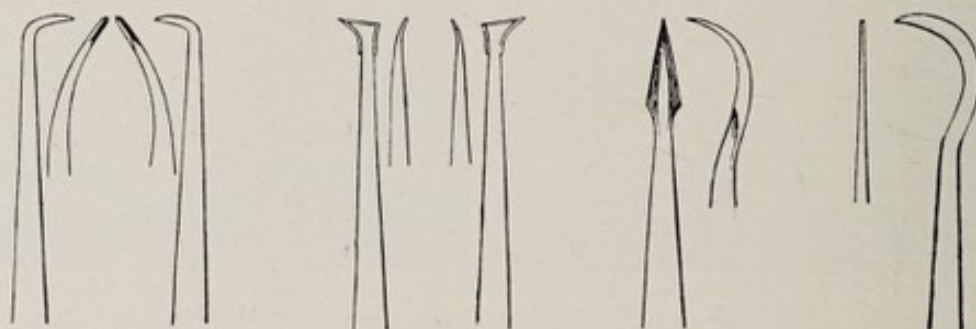


FIG. 1344. A set of six scalers for removing deposits of salivary calculus.

Oftentimes, heavy deposits on the lingual of the lower incisors, particularly if they extend around the proximal angles, may be removed very nicely by using the pair of push scalers from the labial through the interproximal space, the blade being applied with its edge part way around the angle into the embrasure.

For the molars, both upper and lower, deposits of salivary calculus may be removed from most buccal, lingual and distal surfaces with the pull scalers. The cleoid or sickle may also be used about the distal angles of these teeth. The push scalers will often be more convenient for proximal surfaces, the blade being used through the space from buccal to lingual.

This operation involves sufficient practice in the adaptation of the instruments to gain confidence and reasonable skill in management. Both the manner of handling the instrument, and the character of the resistance of the material to be removed, must be learned by actual observation and experience. One should aim at the first movement, to place the edge of the pull instrument between the gingival margin of the calculus and the gum, and pull

toward the occlusal of the tooth, until force enough is applied to break the calculus away. If at one time too much is caught to be broken away with the use of reasonable force, the position of the instrument should be changed so as to remove a smaller portion at first. In using the push instrument, care should be exercised to have a sufficiently good finger rest so that the instrument may be prevented from plunging forward with the sudden breaking away of the deposit and injuring the near-by gum or other soft tissue.

In connection with the scaling operation, the dentist or his assistant should frequently flood the mouth with a jet of warm physiological salt solution from a large rubber bulb syringe. This not only keeps the field of operation clear, but is very pleasant and comforting to the inflamed tissues. The preferred style of syringe is shown in Figure 1345. This syringe has a large opening in the end of the nozzle, so that a strong stream of water may be applied with sufficient force to thoroughly cleanse any space or depression

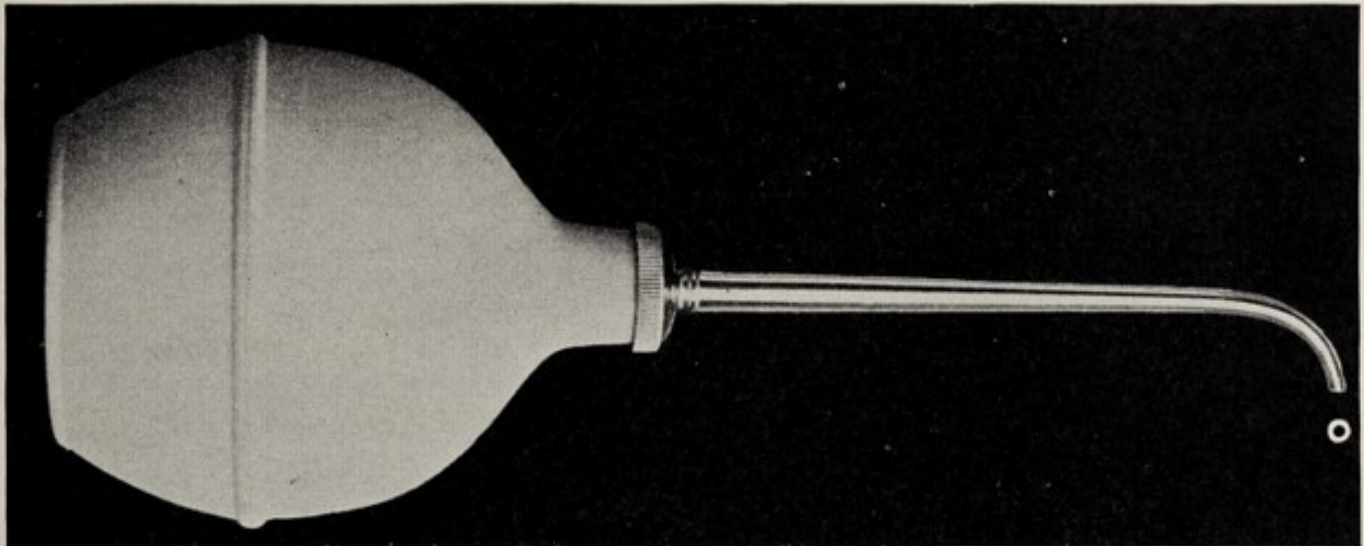


FIG. 1345. The large rubber bulb syringe used for rinsing the mouth and for irrigation for all purposes in the mouth. Illustration actual size.

about the teeth. Care should be exercised to avoid injury to the soft tissues and thus prevent unnecessary bleeding. If much inflamed, the gums bleed very freely. In such cases, the bulk of the deposits should be removed at the first sitting, and the patient should be dismissed for a few days. At the next sitting, the inflammation should be much reduced, and a more thorough operation may be performed. In cases in which there is much calculus widely scattered among the teeth, the operation is tedious, and may be completed at a second appointment. One should not be in a hurry to get through.

Following the removal of the deposit, at the same sitting, or at a subsequent sitting, if there is much inflammation of the adjacent soft tissue, the surfaces from which the deposits have been removed should be carefully polished with powdered pumice and water, using rubber or wooden disks, or points of various shapes,

also orange-wood sticks in the hand polisher. These should all be used with great care not to injure the gingivæ. In some positions, and particularly in cases in which the interproximal tissue has been more or less destroyed, polishing tapes may be used. It should be remembered that the normal attachment of the gingivæ on the proximal surfaces of the incisors is very much closer to the incisal edge than on lingual or labial surfaces, and there is danger of cutting away the proximal attachment in the careless use of strips. In any position, strips should be used with the greatest care.

CARE OF TISSUES. During the time of removing calculus, and in the more severe cases for a brief period afterward, the dentist should look after the cleaning of the teeth himself, for it is fair to presume that a patient who has badly inflamed gums from this cause, has not been in the habit of brushing the teeth properly, and could not be expected to do so until after the inflammation shall have subsided. In fact the use of the toothbrush is often contraindicated for a few days.

In addition to the removal of the deposits, the treatment up to the time when the inflammation shall have subsided, should consist of the most thorough mechanical cleansing with the least possible irritation. This may be best accomplished by using warm salt solution in a rubber bulb syringe. This will remove all accumulations of micro-organisms, their products and other debris from the surface of the inflamed areas and thus advance the healing process. A half-dozen or more syringefuls of the solution should be forced through the interproximal spaces, under and about the gingivæ, giving especial attention to the inflamed areas. The sense of comfort to the patient as a result of several such treatments will often be sufficient to induce the patient to become an enthusiastic user of the syringe in the subsequent care of the mouth.

For reasons which will be fully mentioned later, no antiseptics should be used. It should be recognized that the treatment of this condition, with our present knowledge of it, is purely mechanical. Micro-organisms grow luxuriantly in these deposits, and have the principal part in causing the inflammation and suppuration of the soft tissues. Antiseptics are harmful rather than helpful in treating these inflammations.

CARE BY THE PATIENT.

As soon as the inflammation subsides the patient should be trained in doing the necessary cleaning. This is just as important as the removal of calculus. The dentist should avail himself of every opportunity to impress this fact. The operation can be of only temporary benefit unless the patient cooperates. There is nothing permanent in the simple removal of calculus. Permanence must depend upon the daily habit of the patient. It must become a part of the patient's care of his or her person. It is the dentist's duty to do this teaching. There seems to be no doubt but that the deposits could be prevented or at least greatly reduced in many cases by patients who are willing to limit their diet in quantity.

It has been found worth while to refer to the diet experiments in relation to deposits. However, the majority of patients are more likely to effectively prevent deposits by brushing than by limiting their diet, and brushing is, therefore, the safer treatment. As a matter of fact both should go together.

Some patients will be very willing to do their part, but will need watchful care and instruction. Others will take it up easily from the start. The most difficult thing is to instill the idea of perfect regularity in doing this cleaning. It is difficult to accomplish this, although it is absolutely essential to success.

As a first step in the training of the patient, the dentist should point out the places where the deposit has occurred and explain how necessary it is that these areas be brushed at least twice daily, if redeposits are to be prevented. The patient should understand that the deposit is soft at first and remains so for twelve hours or more, and that during this time it may be easily removed with a brush and plain water. Absolutely nothing else is required. Particular emphasis should be laid on the fact that to miss the brushing of these areas for a single day may mean that there will be sufficient hardening of a slight amount so that it can not be removed with the brush, also that this slight deposit, by its roughness, serves to attract and hold future deposits.

The dentist should see to it that the patient has proper brushes, and he should by using his brush in his own mouth demonstrate the positions and movements necessary. He should, in many cases select the brushes to be used and instruct patients in the proper methods.

The use of the rubber bulb syringe by the patient as a part of the daily routine of cleaning the mouth will be appreciated by most patients when they have once learned its use and the sense of comfort which it gives. While deposits of salivary calculus may be prevented with nothing else than the brush and water, the gingivæ may be kept in better condition by the use of the syringe and thereby reduce the opportunity for future deposits.

From what has been said, it should be quite obvious that tooth-powders, tooth-pastes and mouth washes are not indicated in the treatment of these inflammatory conditions.

SUBSEQUENT EXAMINATIONS. Every patient for whom deposits have been removed should be impressed with the importance of returning at stated intervals for inspection and the correction of errors in cleaning. The frequency of such visits should depend upon the case, and the earnestness of the effort on the part of the patient. In cases in which there has been serious neglect, the patient should be requested to return within a month. If it is then apparent that the cleaning is being well done, a longer period may be given before the next visit. For persons who have become well trained and are in earnest in the care of their mouths, appointments every six months are sufficiently frequent, and for many such people, little or no deposit will be found even then. The den-

tist should take the responsibility for the recall of the patient. Many patients will welcome such a plan and will be so impressed with the whole scheme of treatment and the interest manifested by the dentist, that they will undertake their part more earnestly.

On the occasion of each subsequent examination, the dentist should refer to his previous examination record, and should make a careful inspection of all positions from which deposits were removed to note how successful the patient has been in the cleaning. Whenever a deposit is found, it should be pointed out to the patient, and directions given for the better care required in the future. At the same time a record should be made of whatever deposits are found and the patient should know that this is done. Then the deposit should be removed.

Such a plan of recording places of deposit, and checking up the care by the patient at each sitting, together with the education of the patient as to the nature of the deposit and training in the cleaning necessary to its prevention, all carried out with an enthusiasm and earnestness on the part of the dentist, will not fail to procure the earnest coöperation of most patients. This is especially true if the patient's attention is called to the almost certain eventual loss of those teeth which are neglected. For such persons this plan of treatment will not fail. It is dependable.

FIXATION OF TEETH THAT HAVE BEEN LOOSENEED.

It not infrequently happens that teeth which are loosened as a result of the destruction of a part of their investing tissue by the deposit of salivary calculus will with proper treatment again become tight. If, following the removal of the deposit, the teeth are kept clean, the inflammation of the peridental membrane will subside and the teeth will be held against direct pressure in mastication, if the occlusion is squarely down upon the teeth. If, however, the teeth should be inclined, or the wear of the surface should be more on the buccal than on the lingual, or the reverse, the force exerted is inclined to drive the tooth to the one side or to the other. In cases in which the destruction of the membrane has not been too great, the loose teeth may be fixed in position by an artificial appliance which will hold them against lateral strain, and thus give the remaining investing tissues opportunity to regain their normal tone. Many of these loose teeth will, as a result of the reduction of the swelling around the apex of the root, the thinning down of the membrane and the apparent strengthening of the fibers, do service for many years, if they are kept clean. After several months the fixture may be removed. After the teeth have become firm, they will usually do better without the appliance, because they can much more readily be cleaned.

Whatever form of appliance is used, it should be so constructed that it will be entirely free from the soft tissues, being attached to the crowns as far away from the gingivæ as possible.

It should be so made for the double purpose of avoiding irritation to the gingivæ, and to permit the most thorough cleaning of the portions of the teeth near the gingivæ.

There are many ways in which such teeth can be fixed in position. Comparatively narrow bands may be fitted to the crowns without impinging on the margins of the gingivæ. These bands should include the loose tooth or teeth and at least one firm tooth on either side. In cases in which such an appliance is to be placed on the lower incisors, the bands may be made tolerably heavy and well reinforced with solder, so that the labial portion for each tooth may be cut away after the appliance is cemented to place. This will then show of the gold only what will appear to be a row of proximal gold restorations.

Other plans will be quite as satisfactory. It is not within the scope of this book to describe these in detail; only to call attention to the advantage of such appliances in some cases in which the teeth are loose, but have a considerable portion of their investing membranes remaining. When teeth have become so loose, on account of the extensive destruction of the investing tissues, that they will not be likely to again become tight, they had better be extracted at once, and replaced by a bridge or some other appliance.

Gingivitis Associated with Deposits of Serumal Calculus

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ILLUSTRATIONS: FIGURES 1351-1358.

This distinct type of gingivitis is caused by the deposit of serumal calculus on the enamel in the gingival crevice. Serumal calculus is a term applied to the deposit occurring on the enamel under the free margin of the gingivæ, or on the cementum after the periodontal membrane is detached. The term was first suggested in a paper * read before the Illinois State Dental Society in 1882. The material for the deposit of this particular type of calculus appears to be brought into the gingival crevice with the exudate which occurs as a result of inflammation.

CAUSES OF DEPOSIT AND CONDITIONS OF OCCURRENCE.

The underlying causes of the deposit of serumal calculus are not different from the causes of deposits of salivary calculus. The serum, which may be discharged into the gingival crevice, as a result of inflammation, may or may not contain calco-globulin, but under those conditions already described under which calco-globulin is present in the fluids secreted from the salivary glands, it should be expected that it would be present in the other fluids of the body, and excreted with them. Serum which is discharged into the gingival crevices should contain its proportion of calco-globulin, and depending on the quantity, it might find a place of deposit on the enamel of the gingival crevice. Doubtless much of it passes out from the gingival crevice and becomes mixed in the saliva, while that which remains is not disturbed by the cleansing of mastication, nor by the artificial cleaning methods ordinarily employed.

Therefore, it seems logical to state that there may occur a localized or a general deposit of serumal calculus on the enamel of the gingival crevices, as a result of the irritation of the gingivæ in mastication. An excessive deposit would be expected when there is unusual irritation or inflammation of the gingivæ from other causes, since under such conditions an excessive amount of serum would be discharged into these crevices. A deposit of serumal calculus may therefore be found in a single crevice and nowhere else, in a case in which the tissue overlying the particular space was irritated or inflamed, yet the amount of calco-globulin

* Phagedena Pericementi, by G. V. Black. Proceedings Illinois State Dental Society, 1882, p. 93. See p. 98, second paragraph.

in the serum might be so slight that over a long period of time there would be insufficient quantity to make an appreciable deposit.

It should also be recognized that some individuals apparently practically never have an excess of calco-globulin discharged with the saliva, or other secretions, and deposits of serumal calculus would not be found in the mouths of such persons. However, since many of the inflammations of the gingivæ continue year after year without attention, there will usually be a deposit in such places, because it is probable that few persons are continuously free from paroxysms of excess of calco-globulin.

It should generally be expected that deposits of salivary calculus would be found in mouths in which deposits of serumal calculus are present, as the same condition would result in the outpouring of calco-globulin in the saliva simultaneously. The deposits of salivary calculus need not necessarily be present, however, because the local conditions in those positions in which salivary calculus would generally be found, may be unfavorable for an accumulation of the deposit; or, accumulations which have occurred may have been removed by the vigorous use of the teeth in mastication, or by artificial cleaning, neither of which would disturb the serumal deposit.

It should generally be the case that no deposits of salivary calculus will be found in those mouths in which well-marked inflammations of the gingivæ have existed for a considerable time, say a year or more, without any deposit of serumal calculus having occurred in such positions. In such cases there would have been a continuous outpouring of an excessive quantity of serum from the inflamed areas, and if there had been insufficient calco-globulin to form deposits in such positions, it would be expected that no calco-globulin had been secreted with the saliva during the period of inflammation.

The fact that this type of deposit is very frequently present on the enamel in cases of traumatic inflammation of the gingivæ, also in cases of inflammation with detachment of the peridental membrane, suggests that a careful examination be made for these deposits on the enamel in all cases of inflammation of the gingivæ.

COMPARISON OF SERUMAL WITH SALIVARY CALCULUS. Serumal calculus is more compact and is harder than salivary calculus. Its color is a dark brown or black, often intensely black, and if broken, it is lustrous when washed and dried. No analysis of this calculus seems to have been published. This is probably because of the difficulty of obtaining it in sufficiently large quantities. There is probably little difference in either the structure or chemical composition.

A ground section of a deposit of serumal calculus is shown in Figure 1351. By comparison with a similar section of a deposit of salivary calculus in Figure 1327, it will be noted that both show

the same rounded forms. The lines of accretion can be seen in this deposit of serumal calculus.

GINGIVITIS DUE TO THE DEPOSIT. The first effect of a deposit of serumal calculus in the gingival crevice is to cause increased irritation of the gingiva. If the supposition expressed above is correct, this irritation tends to an increase in the deposit by causing more serum to be poured into the space, and this in turn increases the irritation. The deposits adhere very closely to the enamel of the gingival crevice. See Figures 1352 to 1357. The overlying gingivæ have a darker cast than normal, caused by the dark color of the calculus showing through the tissues which cover the deposit.



FIG. 1351. Photomicrograph from a section of a crumb of very black serumal calculus. It gives a slight showing of spherules. The irregular veining shows lines of accretion.

A strict analysis of the above statements, suggests that it is incorrect to list serumal deposits as a cause of gingivitis, because it appears that there must be at least a slight preceding inflammation, of which the deposit is the result. However, the first intimation that the dentist may have of such an inflammation is the finding of the deposit. After a deposit occurs it appears to be the dominating factor, causing additional inflammation of the gingivæ, which eventually involves the deeper tissues. Because of its relation to these deeper inflammations and the importance

of its removal in prevention, it seems justifiable to list it as a cause of gingivitis.

COMPRESSION OF DEPOSITS BY THE GINGIVÆ. It seems probable that the greater density of serumal as compared with salivary calculus may be due to compression from the gingivæ while the mass is soft. The usual form of the scale is flat, and its smooth, rounded surface suggests that it is compressed against the surface of the enamel.

VARIATIONS IN LOCATION OF DEPOSITS. In many cases the deposit of serumal calculus is confined to small points on the buccal, labial or lingual surfaces of the enamel, rather than the proximal surfaces. Sometimes rings of this calculus will completely encircle many teeth. Three very excellent illustrations are shown in Figures 1355, 1356 and 1357.



FIG. 1352.

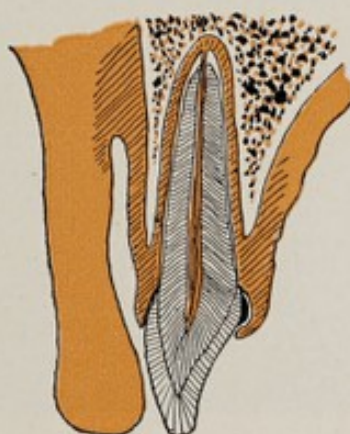


FIG. 1353.



FIG. 1354.

FIG. 1352 shows a deposit of serumal calculus under the gingiva on the labial surface of the enamel of a lower incisor tooth.

FIG. 1353 shows a similar deposit on the lingual surface of an upper incisor.

FIG. 1354 shows an upper molar with deposits of serumal calculus on the enamel of both the buccal and lingual surfaces.

Deposits of serumal calculus may be found on any or all of the teeth; although it seems to occur most frequently in the anterior part of the mouth, especially on the incisors and cuspids, less often on the bicuspid and least frequently on the molars. The third molars are involved more frequently than either the first or second molars, apparently because their gingivæ are more subject to inflammation.

It is very liable to involve and destroy the membranes of one or two or several teeth and leave others uninjured. This occurs because of the fact that a suppurating pocket once established is likely to progress very slowly until the tooth is lost. As

has been mentioned, there may be a general deposit in many or all gingival crevices, or in any particular position in which an irritation of the gingiva has occurred.

SUPPURATION INVOLVING PERIDONTAL MEMBRANE. The greatest danger from the inflammations caused by these deposits is to the attachment of the peridental membrane. As the inflammation increases, suppuration usually occurs. The point of the beginning of suppuration is near the cemental line, and a little of the attachment of the peridental membrane is destroyed. As this progresses, the gingiva may shrink away and become shorter, exposing the first deposit. Then another deposit is apt to occur in the space gained. By this time, the suppuration of the adjacent peridental membrane may form a pocket along the side of the root of the tooth and a suppurative pericementitis is thus established.



FIG. 1355.

FIG. 1356.

FIG. 1357.

FIGS. 1355, 1356, 1357. Three molar teeth showing "rings" of deposit of serumal calculus on the enamel of the subgingival space.

One case was observed in practice in which a narrow pocket of slight depth, was present at the disto-labial angle of an upper lateral incisor. It was caused by a small deposit of serumal calculus attached to the enamel in the gingival crevice. There were also several flakes elsewhere in the mouth, but this was the only point of suppuration. Following the removal of the deposit, the inflammation subsided, but afterward there was a scallop in the crest of the gingiva at that point, because of the detachment of the peridental membrane from the tooth and the injury of some portions of other supporting tissue. This patient was under observation for ten years afterward, and there was no other deposit of serumal calculus. Neither was there any betterment of the deformity of the gingiva by reattachment over the space of the destruction of the fibers of the membrane.

Treatment of Gingivitis Due to Deposits of Serumal Calculus

The treatment of inflammations of the gingivæ, with which deposits of serumal calculus are associated, should be along the same general lines as the treatment of inflammations caused by deposits of salivary calculus. The principal points of difference are in the instruments used and technic employed in removing the deposits, and the greater importance of the rubber bulb syringe both in the care by the dentist and in the after treatment by the patient.

It should be understood that the deposit often occurs as a result of any form of gingivitis. In those cases in which there is apparent an exciting cause of the inflammation, other than the deposit, it will, of course, be necessary to remove such cause, whatever it may be. The different injuries to the gingivæ and their treatment, are considered elsewhere.

The treatment should consist: First, of the thorough removal of the deposits, and the care of the tissues by the dentist until the inflammation has subsided; second, the training of the patient in the means of preventing redeposits; third, subsequent examinations at stated intervals to criticize the care by the patient and to remove any deposits which may have occurred.

REMOVAL OF DEPOSITS. The technic necessary for the removal of deposits of serumal calculus is an entirely different matter from the removal of deposits of salivary calculus. Serumal calculus is deposited in the gingival crevices; it is always covered by the gingivæ at the time the deposit occurs and is therefore hidden from view, except in a limited number of cases in which the tissues may have receded after the deposit was formed. These deposits are usually in the form of flattened scales which cling very tenaciously to the surface of the enamel. It requires a very sharp instrument and considerable force to dislodge them. Care should be exercised to do the least possible injury to the gingivæ in connection with this operation.

As mentioned in connection with the treatment of gingivitis caused by deposits of salivary calculus, a careful record should be made of the positions in which deposits are found when the mouth is examined. Additional entries should be made for deposits found which were not previously noted, with the intention of referring to it and comparing the conditions found on subsequent examinations.

In the removal of serumal calculus, special instruments should be used. These should have narrow, flat blades. The blades should have square ends, ground with very sharp edges for use with a push motion, or should be armed on the flat side with a short blade, in hoe form, with a cutting edge, which may be used with a pulling motion. These edges should be kept very sharp to be

effective. The deposits may be well removed by either form of instrument. Some operators have preferred one of these forms, some the other. In the use of either form, the greatest difficulty is to succeed in removing the calculus without injuring the attachment of the peridental membrane at the cemental line.

In the actual operation, the calculus is found and its position clearly mapped out by the movement of the sharp edge of the blade over the enamel of the gingival crevice. One should learn to detect serumal calculus by the sense of touch. This may be done best by passing any one of the scalers over serumal deposits which have been discovered, and noting carefully the sensations conveyed to the fingers by the motion of the instrument end over the calculus. One may soon learn to determine very accurately the form of nodules, or even of very thin scales, in this way.

Nodules are likely to be found on the enamel only in those cases in which the pressure contact of the gingivæ against the enamel has been lost by the detachment of the gingival group of

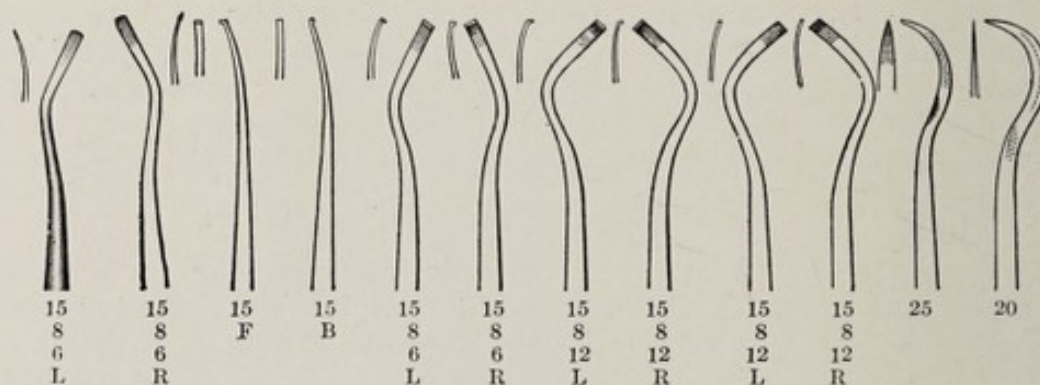


FIG. 1358. A set of scalers for removing deposits of serumal calculus.

fibers of the peridental membrane. Deposits on the cementum are generally of the nodular form.

It will be found that the form of the deposit will vary from thin scales to small nodules, the moderately thin scales predominating. Many of these will be very close to the attachment of the soft tissue at the cemental line. Suppuration will have caused the detachment of more or less of the adjacent peridental membrane about others. The majority will have been deposited a little apart from the attachment of the soft tissue at the cemental line.

INSTRUMENTS AND INSTRUMENTATION. By referring to the accompanying illustration, Figure 1358, it will be noted that there are twelve instruments in the set of scalers designed for the removal of these deposits. These consist of three pairs of pull scalers, and one pair of push scalers, one instrument of sickle form and one of cleoid or claw form. The set also includes a pair of peridental membrane explorers. These have smoothly rounded ends and were especially designed to examine the line of attachment of the peridental membrane.

In the use of the pull form of the instrument the edge of the blade should be slid under the gingiva with the blade in contact with the enamel until its movement is stopped by the deposit, the blade should then be gently lifted from the enamel and carried over the deposit until it is felt to drop against the enamel beyond the margin of the deposit. Then pressure and a sharp pull should be made to bring the scale or nodule away. Care should be exercised in the manipulation of the instrument not to pass it too far beyond the deposit and thus injure the tissue attached to the root. On the other hand, if the edge of the instrument is not passed over the margin of the deposit, the instrument may slip over it and bring nothing away. It requires considerable practice in this instrumentation to do it deftly.

The motions of the push scalers are the reverse of those of the pull scalers. The edge of the blade is lodged against the margin of the scale, and a push made to dislodge the deposit. In using these instruments, there should be a secure finger rest, so that the danger of the instrument plunging ahead into the soft tissues will be avoided. The push scalers are most conveniently used on the proximal surfaces of the teeth, with a motion from buccal or labial to lingual. A pair of right and left scalers, recently designed by G. R. Lundquist, are ideal for the proximal surfaces, particularly in the bicuspid-molar regions. See Figure 1538.

The operator should usually see the patient again within a few days, and examine very carefully for particles which may have been overlooked at the first sitting. These may be shown by points of redness of the gingivæ, or may have to be searched out with the scaler. In a large proportion of cases the explorer may be introduced, and in cases of doubt, the gingivæ may be lifted a little apart from the tooth, so that one can see into the crevice for the detection of very thin scales. In cases in which a number of teeth have deposits, the operation is apt to become very tiresome. The treatment should not be done hurriedly and should often be adjourned to another sitting. During this operation the syringe and warm water should be used frequently for washing the gingival crevices to remove broken particles of deposit and clear away blood which may otherwise impede the operation.

CARE OF THE TISSUES BY THE DENTIST. The after treatment of the gingivæ, following the removal of serumal calculus, is simple. They should have a very thorough washing from the syringe with physiological salt solution, using it plentifully, and in such manner as to wash the gingival crevices clean. This should be carefully explained to the patient, and during the washing, the patient should be asked to note particularly the sensation of the gingivæ, so that he or she may know when they have this sensation in their own efforts with the syringe. The position of the end of the syringe in relation to the gingivæ is shown in Figure 1541, and the technic is given in detail in Volume III, page 33. No other treatment is necessary. No medication is indicated. In the cases now under

consideration, in which the inflammation is confined to the gingivæ, and there has been little or no detachment of the peridental membrane, the tissues will return to their normal condition within a few days.

CARE BY THE PATIENT. The most important training which the patient should receive for the after treatment of this condition, is in the use of the syringe mentioned in the preceding paragraph. The bulb of this syringe fits very nicely in the hand and is convenient for patient use. If new deposits are to be prevented, this must be accomplished by thorough and frequent cleansing of the gingival crevices, so that all of the calco-globulin which is brought to the spaces will be removed before it becomes hard. Yet this is probably not the most important function of the syringe, for by its use the gingivæ are maintained in better health which prevents the disposition to the deposit of serumal calculus. Such cleaning must be done without irritation to the gingivæ. This may be easily accomplished by the patient by washing these spaces twice daily with the rubber bulb syringe and water. This should be a part of the routine care by persons in whose mouths these deposits recur within a period of from six months to a year.

Patients should also receive very specific directions in the use of the tooth brush to stimulate the circulation within the gingivæ. This instruction is generally most effective if the dentist will demonstrate the technic with a suitable brush in the patient's mouth, while the patient observes with a hand mirror.

Nothing is to be gained by the use of mouth washes, tooth-powders, etc., in the care of this condition. It is entirely a question of the thorough mechanical cleansing of the spaces.

SUBSEQUENT EXAMINATIONS.

When each patient is dismissed, there should be an understanding regarding the time when the next examination should be made. If it is agreed that the dentist shall notify the patient when the time arrives, a memorandum should be made to carry out such an arrangement. How soon the patient should return will depend entirely upon conditions. It may be desirable to set a time within a month, if for no other purpose than to make some inquiry as to how the patient's care is progressing. Thereafter, for most patients an examination every six months will be sufficient.

Gingivitis Caused by Injuries

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ILLUSTRATIONS: FIGURES 1371-1383.

THE gingivæ stand in the position of protection to the deeper investments of the teeth and their attachment in their bony alveoli. These attachments, and the preservation of them, are of first importance to the functions of the teeth. It is the dentist's duty to look as closely after the health of these tissues as that of the hard tooth tissues, and to conserve and protect them from injury to the fullest extent possible.

Formerly it was generally believed that most of the cases of destructive diseases of the investing tissues of the teeth were caused by deposits of calculus, and unquestionably the percentage of cases due to deposits was much greater in former years than now, the gradual reduction being due to the better home care. A critical examination of the mouths of a large number of adults will establish the fact that the majority of cases at the present time result from slight traumatisms and irritations of the gingivæ, and that deposits of calculus are the first cause of a minority. Most cases are later complicated by deposits, and these have often been mistaken for the exciting cause. It frequently requires very careful study of cases, especially those which have made considerable progress, to determine the beginning or first cause.

FREQUENCY OF DIFFERENT FORMS OF GINGIVITIS.

As to the frequency of the various causes of gingivitis, no thoroughly conclusive statistics have been collected, although definite records have been made of a sufficient number of mouths to give at least a fair idea. In a paper * read before the National Dental Association in 1913, a report was made of critical examinations of the gingivæ of five hundred young adults, who were the private patients of a selected group of dentists in various parts of the country. The following quotations from the report are presented:

"While considerably more than five hundred mouths have been examined, there will be presented at this time the summary for a tabulation covering exactly five hundred cases, selected by eliminating the cards for all persons younger than twenty or older than thirty-five years, also by eliminating cards for all persons having lesions of the peridental membrane. This summary is, then, a record of the regions of gingivitis found in the mouths of

* Something of the Etiology and Early Pathology of Diseases of the Peridental Membrane, With Suggestions as to Treatment. Arthur D. Black, Dental Cosmos, Vol. LX, 1913, p. 1219.

five hundred young adults, between twenty and thirty-five years of age, the average being 26.3, none of whom had detachments of the peridental membrane.

"Of the five hundred mouths, twenty-five were reported as having no gingivitis, exactly five per cent. Of these twenty-five, but seventeen had all contacts in good form. Each of the other eight had one or more open contacts, but no inflammation of the gingivæ at the time of the examination. In the mouths of the remaining 475 persons, there were reported 4265 regions of gingivitis, an average of 8.53 per person for the 500 examined.

In making these examinations, each of the four axial surfaces of each tooth was considered as one region, and the inflammations were tabulated accordingly.

"There were 1348 regions due to deposits of salivary calculus; these were in the mouths of 198 persons, making an average of 7.8 per person. It should be stated that reports recorded a deposit on more than one surface of the same tooth in 123 instances. The very large majority of these were lower incisors marked as having deposits on both the lingual and labial surfaces. The percentage of the 500 patients examined who had deposits of salivary calculus is 39.6. The percentage of all of the regions of gingivitis reported as directly associated with salivary calculus is 31.6.

"There were 563 regions reported as showing serumal deposits, in which no other cause of gingivitis was recorded. These were in the mouths of 75 persons, an average of 7.5 regions per person. The percentage of the 500 examined who had deposits of serumal calculus is 15. The percentage of all of the regions of gingivitis reported as having serumal deposits is 13.1.

"There were 33 mouths in which deposits of both salivary and serumal calculus were recorded, making a total of 140 persons having either kind or both. This leaves 360 of those examined for whom no deposits were reported.

"There were 2354 regions of gingivitis due to other causes than deposits, subdivided as follows: 783 were due to bad margins of fillings or crowns, 496 to lack of contact of proximal fillings or crowns, 305 to improper contact of proximal fillings or crowns, 263 to malpositions or atypical forms of proximal surfaces, 255 to lack of contact of teeth having no caries of proximal surfaces, 233 to caries of proximal surfaces, and 19 to worn contacts. If the regions due to malpositions, etc., to lack of contact of undecayed teeth, to caries, and to worn contacts, are not counted, there remain 1584 regions, the large majority of which are due to imperfect dental operations. These are more than 37 per cent of all regions of gingivitis reported. The percentage of all regions of gingivitis reported as due to trauma is 55.1. For all persons included in the tabulations there is an average of 4.7 regions of gingivitis per person due to trauma."

It will be observed that 95 per cent of all persons included in the tabulation had one or more regions of gingivitis and that the average number of regions per mouth was 8.53. This means that 19 out of every 20 young adults who apply for examination have an average of more than eight regions of gingivitis which need attention. This statement alone should impress the necessity for greater care in the examination of cases and the institution of procedures for the prevention or cure of such inflammations. It will also be noticed that less than one-third of the regions of gingivitis were caused by deposits of salivary calculus, and less than one-sixth by deposits of serumal calculus, more than half of all regions being caused by injuries and irritations. Attention is especially called to the fact that 1584 regions out of the total of 4265, or about 37 per cent, were reported as due to imperfect dental operations.

ATTITUDE OF THE PROFESSION TOWARD INJURIES OF THE GINGIVÆ.

The changes in the attitude of dentists toward the preservation of the gingivæ form an important element in the development of dentistry. From a subject in which no interest was manifested, it has become one of almost vital interest to all the better class of men of the profession.

In the days of non-cohesive gold foil, it was practically impossible to restore the form of a proximal surface of a tooth, if the enamel of the marginal ridge had broken away. The proximal surface was first cut with a file so as to incline the surface toward the center of the tooth and the restoration was finished in the same plane. If two proximating surfaces were so treated, a V-shaped space was left with the point of the V toward the septal gingiva, which was injured by the pressure of food in mastication and eventually destroyed as a result of impactions of food between the teeth.

Dr. Robert Arthur reported* the discovery of the cohesive property of gold in 1855, which presented the opportunity to restore contours and contacts, although the desirability of doing so was recognized by very few practitioners. In fact, sixteen years later, Dr. Arthur,† who was a leading practitioner of his time, wrote a book in which he recommended the cutting away of the proximal contacts to prevent proximal decays. This is possibly the best example of the failure of the profession of that day to recognize the protective function of the gingivæ in the conservation of the periodontal tissues.

For twenty-five or more years afterward, or until about 1900, it was the custom to drive heavy wooden wedges between the teeth to gain separation while cohesive gold foil restorations were made, and the septal tissue was severely injured.

* Dental News Letter, Vol. 8, 1855, p. 131.

† Treatment and Prevention of Decay of the Teeth, 1871.

During all of this time, and on up to recent years, there was little appreciation among dentists of the physiological importance of tooth forms or of the relation of these forms to diseases of the gingivæ. Ignorance of the special forms of the contact points and of their function of preventing lodgments between the teeth was profound.

Many practitioners of the greatest ability in manipulation could have reproduced proximal contours and contacts with perfection, but did not do so because they did not seem to comprehend the practicability of preventing diseases of the gingivæ by restoring the natural forms of the teeth.

There is no more promising field for the study and practice of prevention than in the group of conditions which are the exciting causes of the inflammations of the gingivæ. Most dentists seem not to have recognized many of these causes at all; or if they have recognized them, they have failed to appreciate the direct relationship between the apparently trivial gingivitis and the more serious lesion of the peridental membrane which results. It should be understood that a gingivitis precedes the pericemen-



FIG. 1371.



FIG. 1372.



FIG. 1373.



FIG. 1374.

FIGS. 1371, 1372, and 1373 show several diastema between the upper anterior teeth.

FIG. 1374 shows a slightly open contact between the lower bicuspid which has permitted the impaction of food and injury to the bone.

titis in every case, and in view of what has been said relative to the lack of power of reattachment of the peridental membrane to the cementum, it is of the utmost importance that more attention be paid to the earlier lesion, the gingivitis, which can usually be prevented or cured by very simple means.

GENERAL STATEMENT OF CAUSES AND SYMPTOMS.

EXAMINATIONS OF THE GINGIVÆ. Reference has already been made to the procedure in making examinations for inflammations of the gingivæ. The only point to be stressed here is that it is desirable for the best preventive service to train one's self in the discovery of the very slightest swellings and discolorations. Gingivitis due to lack of cleanliness and deposits of calculus should be noted first. Preferably the deposits should be removed and the teeth cleaned before the examination proceeds. If there is much inflammation from these causes, it may be best to delay the further examination of the gingivæ until the next appointment.

THE LABIAL, BUCCAL AND LINGUAL GINGIVÆ should be observed with exceptionally good light, oftentimes with a small lamp inside the mouth, in order to discover slight deviations from the normal color or form. The gingivæ and the gingival region of the gums are normally of even color throughout, and the crests of the gingivæ should be of even thinness except where they have been blunted by deposits of salivary calculus. The effort should then be made to determine the cause of each swelling or redness.

DIASTEMA. The word diastema is applied to the condition in which there is a considerable gap or space between two teeth — so wide that food does not catch. As a rule the epithelial covering of the septal gingiva becomes keratinized and withstands the pressure of food forced against it; the food does not pack, but immediately slides to the labial or lingual. Such cases usually require no treatment. Figures 1371, 1372 and 1373 are reproductions of radiographic films of five diastema between the upper teeth of a patient 20 years of age. It will be noted that the crest of the bone appears to be in perfect condition, except possibly between the lateral incisor and cuspid in Figure 1373. In this, the line of

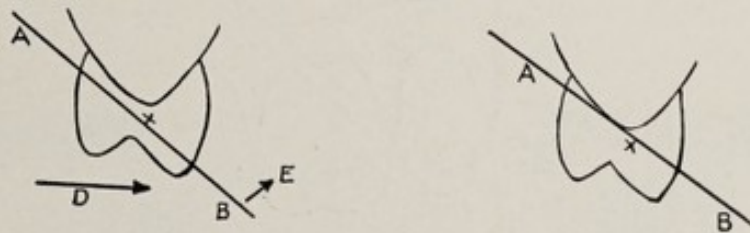


FIG. 1375 illustrates the proper technic in testing a contact with a ligature.

the crest shows a slight irregularity, although the septal tissue did not show any sign of inflammation. By contrast, in Figure 1374, the lower bicuspid stand a little apart; but food has doubtless passed between them and wedged, as is evidenced by the extent to which the bone has been resorbed. The septal gingiva was slightly inflamed.

THE SEPTAL GINGIVÆ. The septal gingivæ should be observed for discolorations, swellings, compressions and recessions at the time when the buccal, labial and lingual gingivæ are examined. Both discoloration and swelling may be noted as a result of almost any type of inflammation. Impaction of food may cause a definite depression of the central portion, while the buccal and lingual portions are pushed outward, and appear as small, congested little tumors. The crests may be depressed by the repeated passing of tooth picks through from buccal to lingual, immediately to the gingival of the position of the contact. The septal tissue may overfill the septal space, due to inflammation or it may have been forced down to almost any level, even below the cemental line.

CONTACTS AND PROXIMAL CONTOURS. The condition of the contact, the contours of the proximal surfaces of the teeth and of proximal restorations or crowns should be next examined. The first step should be to pass silk floss through each contact, to note whether it is normal, weak, open or too broad or rough.

In testing a contact, the ligature should be held as shown in Figure 1375, the finger holds being in the positions A and B, close to the teeth. It should then be passed slowly through the contact from lingual to buccal, or the reverse, as indicated by the arrow, so that it will not snap through against the gingiva. The method of testing the width of the contact is illustrated in Figure 1376. After the ligature has passed the contact, the two ends should be held parallel in the occlusal direction to determine the bucco-lingual width of the contact, as illustrated between the bicuspid. The two ends should then be held parallel in the buccal direction to determine the occluso-gingival width of the contact, as illustrated between the second bicuspid and first molar.

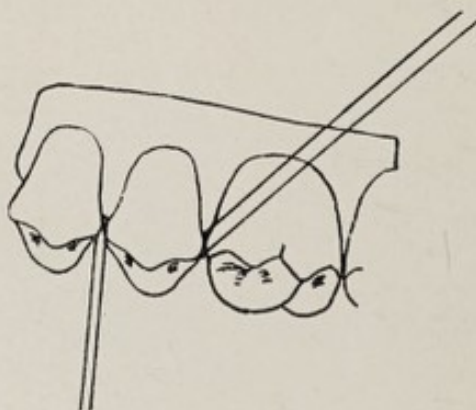


FIG. 1376 illustrates method of determining the width of the contact areas of two teeth.

The form of the proximal surfaces, whether of two teeth that are in contact, or of restorations, should be such that the contact will actually be at a single point, although the proximal surfaces should be smoothly convex. The condition of the contact is indicated by the parallel strands of the ligature, held occlusally or buccally, which should be not more than 2 mm. apart. To better emphasize this point, three illustrations are presented. Figure 1377 is an occlusal view of the upper bicuspid and first molar showing the contact points of three restorations, while Figures 1378 and 1379 are proximal views of several bicuspid and molar contacts shown with radiographs. The contact should be a little to the gingival of the occlusal plane so that food will be guided into the buccal and lingual embrasures as it is divided when pressed against the contact point. In Figure 1378 all of the teeth contain proximal restorations, by which the contacts have been reestablished, while in Figure 1379 the natural contacts of corresponding teeth are shown. The proximal contours, the positions of the points

of contact and the widths of the interproximal spaces in the two illustrations should be compared.

Impactions of food should be looked for and removed when found, and the margins of restorations should be tested with explorers. Decays would, of course, be recorded.

The cause of each region of inflammation should be determined and recorded at the time, following the plan presented in Volume I, page 71, or a similar plan. The various causes and their treatment will be presented in the following pages.

Faulty contact points constitute the chief factor in the causation of this form of disease beginning in the bicuspid and molar region, where the heavy work of mastication is done. More cases of gingivitis are caused by faulty contacts than any other form of injury.

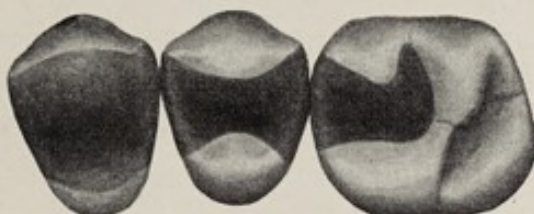


FIG. 1377.



FIG. 1378.



FIG. 1379.

FIG. 1377 is an occlusal view of the proximal contours and contacts of several restorations.

FIG. 1378 is a buccal view of proximal contours and contacts of several restorations.

FIG. 1379 is a similar view of the contours and contacts of the teeth.

If, for any reason, there is a slight opening between two teeth, food which is tough and stringy will be crowded into the interproximal space and cause pressure upon the septal tissue. Or, if the contact is too broad, stringy foods, such as fibers of beef or chicken, are likely to be caught between the flat surfaces and held there, thus injuring the septal tissue. A single such occurrence does little harm, provided the food is promptly removed, but this having occurred a few times, is liable to occur frequently, or even at each meal at which meats or other stringy foods are eaten. This frequent impaction of food against the septal tissues finally becomes habitual, and the tissue is more and more injured by compression.

INFLAMMATION. As a result of this repeated pressure and irritation the tissue is inflamed much of the time. In the earlier stages there may be redness of the gingiva in the particular space, and the festoons will be slightly swollen. The impaction of the food against the central portion of the septum may press the buccal and lingual portions outward in their respective embrasures. The tissue will show marked redness at intervals, and lapse into a sluggish condition of chronicity between times, when many observers would be inclined to regard the appearance as healthy.

SUPPURATION. After a time suppuration occurs in the secluded space between the teeth, affecting especially the attachment of the peridental membrane to the cementum. There is little opportunity, with the ordinary methods of cleaning, to prevent the growth of micro-organisms in these places, and a chronic suppuration is often maintained. This may be of such slow progress as to require years to accomplish the destruction of the supporting structures to the point of loosening of a tooth, or it may proceed more rapidly.

COMPLAINT OF PAIN VARIABLE. There may be complaint of pain during the time food is crowded against the septal tissue. Some patients will complain that food lodges between certain teeth, and they are unable to continue a meal until it has been removed. In the examination of the mouth of another patient, the dentist may find one, two, or several septal gingivæ threatened with serious injury from lodgments of food; or possibly the case will have already progressed so far that the eventual loss of the teeth is inevitable; or there may even be considerable amounts of food debris between the teeth at the time of examination, and yet the patient will insist that no inconvenience has been felt.

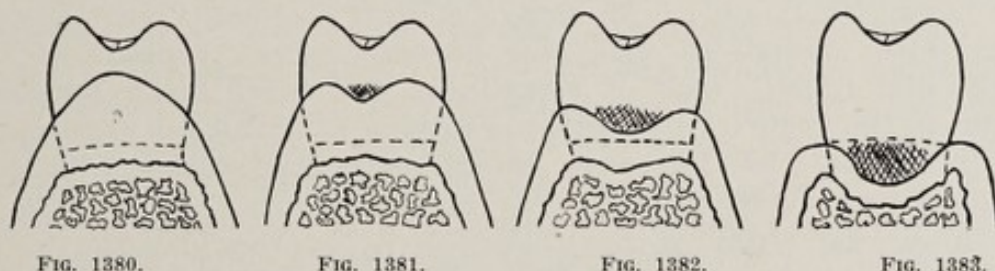
In this class of cases the dentist must be prepared for indifference of patients in whose mouths the peridental tissues are in serious condition; and also to hear great complaint in cases found to be trivial, or even in those of which one can find no sign of inflammation and no apparent cause at a first examination.

The treatment of these cases should be based on the conditions presenting, without regard to the statements of those patients who say they have no discomfort in mastication.

RESORPTION OF SEPTAL TISSUE. As time passes, some resorption of the septal tissue will occur, beginning in the central portion bucco-lingually. This will progress gradually until the septal tissue may be depressed below the buccal and lingual gingivæ, forming a considerable pocket between the teeth. See Figures 1380, 1381,

1382 and 1383. If such cases do not receive attention, the destruction of the soft tissue will continue either as a result of the repeated impaction of food between the teeth, or from the establishment of suppuration within the inflamed tissues. Eventually, the inflammation will involve the peridental membrane at the cemental line, detach it from the cementum and form a pocket alongside the root. Sometimes the pressure and decomposition of food, without suppuration, will destroy the attachment of the peridental membrane. Whenever the peridental membrane is detached from the cementum by suppuration, the difficulties of satisfactory care of the case in the future are greatly increased.

DEPOSITS OF SERUMAL CALCULUS. Deposits of serumal calculus may or may not be present in these cases. Whenever there is an inflammation of the gingivæ from any cause, the quantity of serum poured out into the gingival crevice is increased and a deposit may occur. As these irritations of the gingivæ are often of long duration, deposits of serumal calculus are not uncommon. As previously stated, the deposit is frequently looked upon as the exciting cause of the inflammation, while the real cause, the condition



FIGS. 1380, 1381, 1382 and 1383 illustrate the progressive destruction of the septal tissues by food impaction.

which permits the impaction of food, or which causes the irritation, is overlooked. Certainly a considerable number of cases present, in which there is no deposit.

DETACHMENT OF PERIDENTAL MEMBRANE. Infection and detachment of the peridental membrane follows in practically every case in which chronic inflammation of the gingivæ is neglected. It is for this reason that the causes of these inflammations and their treatment are presented in detail. In cases in which there is deep detachment of the peridental membrane from the root of one, or of both of the proximating teeth, they will move apart and the contact will not be maintained even though it is reestablished by placing a restoration. Such inflammations should not be listed as gingivitis. They are mentioned here to emphasize the point that attempts to restore contacts should not be made under such conditions, for the reason that the teeth will continue to move apart.

Treatment of Gingivitis Due to Injuries

ILLUSTRATIONS: FIGURES 1384-1412.

In view of the fact that there are many conditions which cause inflammations of the gingivæ, the plan will be followed of presenting these under the several group headings, with suggestions as to the treatment immediately following the statement of each condition. The classification numbers on the Chart in Volume I, page 65, correspond with the causes here presented, and it should be understood that the simple procedure of entering a number in the proper location on the examination card will not only record the region of gingivitis, but will also indicate its cause and in most cases the treatment to be employed for its cure.

CLASSIFICATION OF CONDITIONS CAUSING INJURIES AND THEIR TREATMENT

There are so many conditions which may cause traumatic inflammations of the gingivæ, that it is almost out of the question to enumerate all of them. However, it seems to be essential to a better understanding of these causes that those of most frequent occurrence be classified. They are divided into the following groups, which include the majority of causes observed:

Gingivitis due to; first, lack of contact; second, improper contact; third, deviations from the normal smooth contour of the teeth; and fourth, lack of cleanliness and injuries by patients. Some of the injuries caused by dentists will also be mentioned. The inflammations caused by excessive occlusal stress will have separate consideration later.

A careful study of the following pages should serve to fix these so definitely in the mind that they will come to be looked for regularly in mouth examinations. The dentist who follows this plan of examination, with accurate records, will soon come to a better appreciation of conditions and will apply preventive treatment more effectively. Failures to appreciate the very serious inflammations which eventually result from lack of attention to these regions of gingivitis, have led to the loss of all of the teeth of many individuals. Certainly a very considerable percentage of the cases of diseases of the peridental membrane are due to failures to restore proper contacts. The several conditions in each group will be briefly discussed.

Most cases of gingivitis due to injury may be cured by very simple means. There is little in the treatment of any of these conditions which may not be accomplished in a comparatively short time. The difficulty is not so much in the technic to be employed, as in the fact that many dentists apparently have not come to recognize these inflammations as forerunners of chronic suppurative pericementitis.

The gingivitis and pericementitis should be clearly recognized as different stages of the same disease. As previously mentioned,

the connection between the two has not been appreciated, by reason of the fact that the progress is so slow and the elapsed time between the beginning gingivitis and the establishment of an easily recognized pocket is so great that the two are not associated.

The mouth examinations which have been tabulated reveal the somewhat startling fact that there are regions of gingivitis in the mouths of about ninety-five per cent of young adults and that these regions average more than eight to each mouth. The number per person is considerably increased with advancing years. These figures also indicate that in the recent past, about half of all cases of gingivitis should be charged to shortcomings in technic by dentists; these inflammations were the direct result of failures in what the dentist evidently regarded a minor detail, such as a restoration which satisfactorily sealed the cavity and reproduced the occlusal form, but was just a little short of reestablishing a tight contact. The pathology of these lesions is comparatively simple, and should be fully understood by every dentist.

The thought which should be constantly in mind in the consideration of the treatment of these conditions is that these regions of gingivitis may in most cases *be prevented* by the same simple treatment which is employed to cure them when they have occurred. The dentist should, therefore, come to recognize clearly the conditions which cause these inflammations and do whatever may be necessary to prevent them. In the entire field of dentistry no service is of greater value. If each dentist will bring himself to realize that he may be preventing the loss of the entire denture every time he prevents or cures a slight gingivitis, he will come to really appreciate the value of this service.

The technic to be employed in the individual case is usually determined when a proper diagnosis is made. If the inflammation is due to an open contact, it is obvious that an operation should be performed which will restore such a contact to normal. If a contact is not in proper form, the malform should be corrected, whether it be of the tooth or a previous operation. If the patient is, by neglect of care, permitting an inflammation to occur, he should, if possible, be made to take an interest in his own welfare to the extent that the difficulty will be remedied. If he is causing inflammation by improper use of toothpicks, silk floss, etc., his attention should be called to such errors. Each case is likely to present, on careful study, a little problem in itself. The condition of the entire mouth must often be taken into consideration. Often-times the cause of an inflammation in one jaw will be found in the opposite jaw. Some suggestions as to the various forms of treatment may prove of interest.

GINGIVITIS DUE TO LACK OF CONTACT OF THE TEETH

When there is a diastema between two teeth in such form that food is not caught and held between them, the gingivæ may continue indefinitely without becoming inflamed. Such cases re-

quire no attention. In practically all cases, the inflammation of the gingivæ should be the guide for treatment.

An open contact between two teeth may result from a number of causes. In cases in which the separation is slight, so that stringy foods are caught and held between the teeth, the gingivæ are in greatest danger. In some cases the movement of the teeth continues until there is sufficient space so that food is not held between the teeth. Under such conditions the gingivæ are less liable to injury.

SEPARATIONS FOLLOWING EXTRACTIONS. Many cases of slight or considerable separation follow the extraction of a tooth. If a first molar is extracted, for example, the second molar and second bicuspid may be gradually drawn toward each other, causing slight openings of the contacts between the second and third molars, between the first and second bicuspid, and oftentimes between the first bicuspid and cuspid. The illustrations for a similar case, reported in Volume III, are reproduced here as Figures 1384 and 1385. In this case the second bicuspid had remained in contact

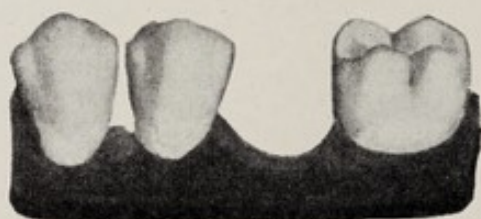


FIG. 1384.

FIG. 1384. A case in which the second bicuspid had moved distally subsequent to the extraction of the first molar.

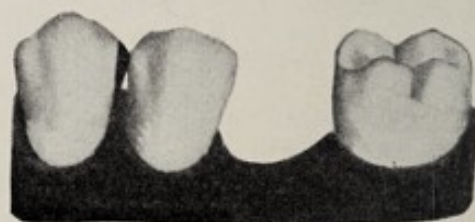


FIG. 1385.

FIG. 1385. The contact between the bicuspid and molar was reestablished with a disto-occlusal restoration in the first bicuspid.

with the first bicuspid for nearly seventeen years after the extraction of the first molar. It then moved distally, opening the contact and a decay occurred in the distal surface of the first bicuspid. In this case the first molar was extracted when the patient was ten years old, and the second molar erupted to the mesial of its normal position. A disto-occlusal restoration was made in the first bicuspid with a gold inlay, re-establishing a tight contact. The occlusion was such that it seemed unlikely that the second bicuspid would move farther.

Figure 1386 shows a case with food impacted between the first and second molars. In this case the second molar had moved distally after the removal of the third molar. The destruction of the interproximal soft tissues was so deep that there was no hope that it would refill the interproximal space even though a good contact were made. Neither molar was loose and it seemed likely that a good contact would be maintained. There was an amalgam restoration in the second molar and it was removed and replaced with a gold inlay, re-establishing the contact. It was made clear to the patient that the only prospect of saving this tooth was for

him to use the rubber bulb syringe twice daily to clean the interproximal space, also that if he did not intend to be faithful in doing this the better procedure would be to extract the second molar at once, and thus assure the continued service of the first molar. To leave the second molar in place without proper care would certainly result in the loss of both teeth. This case is one which concerns only the peridental tissues, as the septal gingiva, as such, was doubtless destroyed years previously. The point in presenting it here is to emphasize the result of neglect of the preceding case.

In many cases of this kind, one should consider the practicability of preventing the teeth from drifting apart by placing a small bridge to serve as a stay appliance, as well as to maintain the full masticating power. Following the extraction of a lower first molar, for example, it would seem unlikely that the patient would suffer any considerable inconvenience in mastication if this

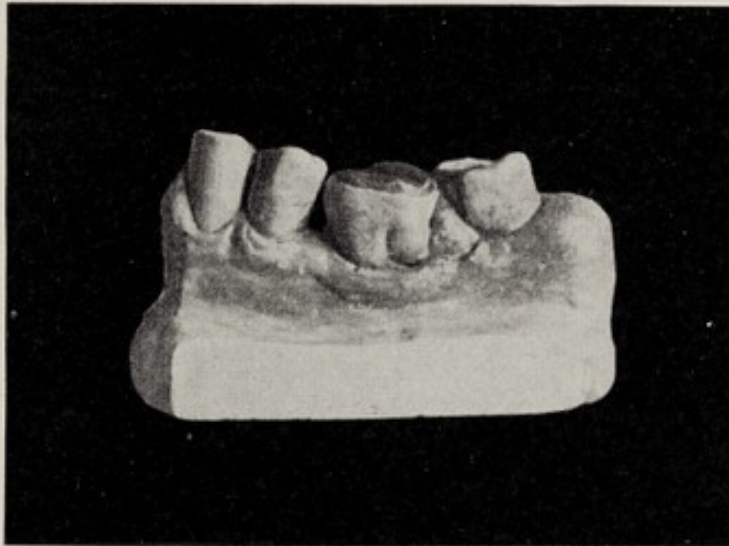


FIG. 1386. Plaster model of a case with a mass of food debris impacted between two molar teeth which were slightly separated.

tooth were not replaced, yet there is the danger of causing inflammations of the gingivæ some years later as a result of drifting and the opening of contacts. The decision should depend in part upon the interdigitation of the cusps which would likely prevent movement and in part on the patient's attitude relative to periodic recalls. If there was the almost certain prospect that the case would be kept under observation the decision might be delayed.

ABNORMAL POSITIONS OF TEETH. There occasionally exists a lack of contact of certain teeth on account of some abnormality of the position of one or more teeth. There will be a slight space between two teeth which are not decayed, and the circumstances may be such that the most practical plan will be to prepare a cavity and establish a proper contact with a restoration. An unusually interesting case of this kind may be reported. The patient, a man about forty-five years of age, was first examined in April,

1913. No cavities were found, and the gingivæ were in good condition, except the septal tissue between the lower right first molar and second bicuspid. The teeth stood nearly a half millimeter apart at the position of the contact points, and the septal tissue was considerably depressed. Inquiry was made as to whether the patient suffered discomfort from food catching between these teeth. He replied: "I should say I do; can you do anything to prevent it?" The situation was explained, and a mesio-occlusal cavity was prepared for an inlay in the first molar. A good contact was established and he was greatly pleased. A few weeks later he stated that he had previously visited six dentists, none of whom had suggested that anything should be done. Within the next year, the other members of the family became patients of the author and have continued as such to the present time.

Another case of a boy 15 years of age, required similar treatment. He had been under the care of an orthodontist for about three years for the correction of a Class 1 case of malocclusion. The lower first and second bicuspid were not in contact on either side of the arch after the appliances were removed and the septal tissue was constantly inflamed from food impaction. The boy had been a difficult patient and the orthodontist was disinclined to try anything further, particularly for the reason that the boy was leaving the city for the summer within a few days and would be available for only a week in September before leaving for school. Under these conditions, after discussing the case with the mother, mesio-occlusal inlays were placed in both of the molars to establish contacts. These were placed in June 1934, and have remained tight. There can be no question but that the placing of the two inlays was fully justified in this case.

Many teeth which occupy slightly abnormal positions have never been in normal contact and, whatever space exists is not likely to change materially without operative interference. Failure or delay in the resorption of the root of a temporary molar may cause a bicuspid to erupt so far to the buccal or lingual of its normal position that there will be no contact with the proximal teeth, except near the cemental line.

EXCESSIVE OCCLUSAL STRESS. Uneven wear of the teeth may cause the opening of one or more contacts which were formerly tight. A cusp of one arch may come too close with too great force between the cusps of two teeth of the opposite arch, causing them to gradually move apart a little, thus exposing the septal tissue to injury. A patient complained of food catching between the lower left first and second bicuspid, which had caused him some discomfort and also inconvenience in keeping the space clean. The gingiva between these teeth was not inflamed at the time of the examination, but it was quite evident that the buccal cusp of the upper first bicuspid had been striking between these teeth in such a way as to force them slightly apart. The sensitiveness of the patient to irritation had caused him to clean the space after each

meal. The buccal cusp of the upper bicuspid was ground sufficiently to relieve the pressure on the lower teeth and within about two weeks the contact was normal. This case was under observation at routine examinations for the next ten years and required no further attention.

Excessive stress on a tooth in the lateral or protrusive movements of the mandible may result in a labial, buccal or lingual movement of a tooth, which will weaken its contacts with the adjacent teeth. A case in point is illustrated in Figure 1387, in the mouth of a man of fifty-five. Incidentally, this was the first time that the patient had visited a dentist. He had no cavities, but the upper right lateral and cuspid had evidently separated some years previously, apparently due in part to the uneven wear of the lower incisors and in part to the protrusive movement of the mandible. There was a pocket about 4 mm. deep between the teeth, with destruction of all of the interproximal tissues to nearly that depth. This condition could have been prevented by a little grinding of the lower incisors and subsequent watchfulness of the case.



FIG. 1387. A case in which the separation of the upper lateral incisor and cuspid had resulted in the destruction of much of the septal tissue between these teeth.

The question of excessive occlusal stress will be discussed in greater detail under a separate heading.

WEAK CONTACTS. When the strength of the trans-septal fibers is insufficient to maintain a tight contact against heavy stress of mastication, an inflammation of the septal tissue is likely to occur. This tissue may appear to be inflamed without noticeable cause. A test of the contact with the ligature will show that the teeth are in proper contact and the ligature may even pass through with a snap, yet if considerable pressure with a large instrument is made distally on one tooth, or mesially on the other, it will be observed that the contact is opened. In chewing, the stress is sufficient in such cases to force the teeth apart momentarily and crowd a few food fibers past the contact against the soft tissue. This may occur several times at each meal, and even though the impacted food is removed with reasonable promptness, the inflammation

and resorption of the septal tissue will usually become gradually worse. These cases are more likely to be neglected than others because of the difficulty in making out the cause of the inflammation. In mouths from which no teeth have been lost, these weak contacts are most frequently observed between upper second and third molars, the third molar moving distally under the stress of mastication. If any tooth in the bicuspid-molar region has been lost, the teeth next to the space are more likely than others to move under stress, because they have lost the support of the extracted tooth.

A weak contact is an intermediate stage to an open contact, although the condition described above may continue for a long time before the contact is actually open.

PROXIMAL SURFACE DECAYS. Proximal decays of bicuspids and molars, which are in normal contact, often progress unnoticed or uncared for until the lateral decay in the dentin along the dento-enamel junction has undermined the enamel of the marginal ridge of the occlusal surface. Under the stress of mastication this occlusal enamel is broken away. The enamel which formed the contact point is then lost and the opportunity is offered for food to be crowded into the cavity and wedged between the teeth. Persons who are taking reasonable care of their teeth will generally report to their dentist at once when this occurs, and the injury to the gingivæ will be temporary and of little consequence. It is in the neglected cases of this type that serious injury occurs.

RESTORATIONS OR CROWNS WHICH FAIL TO MAKE CONTACT. In cases in which restorations or crowns fail to make contact, impactions of food and inflammation of the septal tissue results in exactly the same manner as in those cases in which the teeth stand slightly apart. The treatment consists in doing the least thing that can be done in the particular case to make the restoration what it should have been when it was placed. A restoration may be removed and replaced, or if it happens to be large, it is often best to prepare a cavity in the restoration and thus bring the tooth to proper contour. A gold crown may be built out by a similar operation, or it may be necessary to make a new crown. Porcelain crowns present unusual obstacles; there may be opportunity to build out the contour of a restoration in either of the adjacent teeth. A case report of a woman of about forty follows; there were porcelain crowns on the lower right first and second bicuspids, with slightly open contacts between them and also with the cuspid and first molar. There was a large mesio-occlusal amalgam restoration in the first molar. As a first procedure a Ferrier separator was placed in the second bicuspid-first molar space and the adjustment screws were tightened to determine whether it might be practicable to move the bicuspids mesially to close the contact between the first bicuspid and the cuspid. This was accomplished with no discomfort of consequence to the patient. The separator was immediately taken off, the amalgam restoration was removed

from the first molar, and an inlay preparation was made, also a wax model. The separator was then replaced and tightened to again close the cuspid-first bicuspid contact. The cavity in the molar was filled with base-plate gutta-percha, which was packed tightly against the distal of the second bicuspid crown and allowed to harden before the separator was removed. At the next appointment the inlay was tried in the cavity and found to be a good fit; the contour was slightly overbuilt and it was possible to press it to place without using the separator. All three contacts were tightened so that they were of fully normal pressure, also the contact between the first and second molars, which had been only fairly tight before. Thus four contacts were tightened with a single restoration. The occlusion was adjusted by grinding the

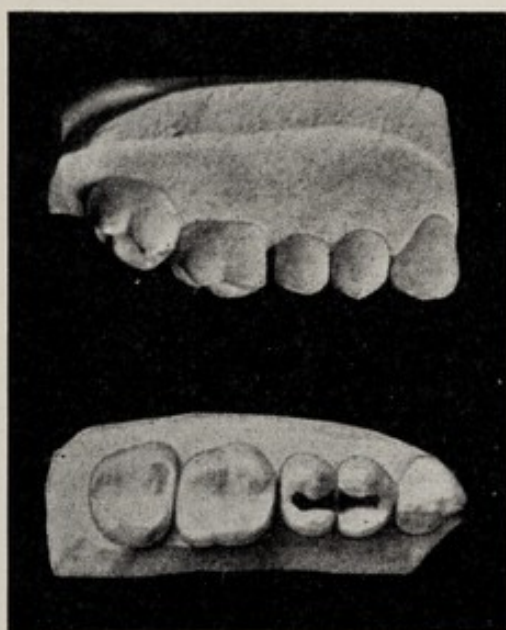


FIG. 1388.



FIG. 1389.

FIGS. 1388 and 1389. A case in which proximo-occlusal restorations had been made in the bicuspid without reproducing the normal contours. As a result, the second bicuspid moved mesially, opening the second bicuspid-first molar contact. The condition was corrected by moving the second bicuspid to its proper position and replacing the restorations.

porcelain crowns, also the mesially inclined planes of the cusps of the upper first molar. The patient was then dismissed.

LOSS IN WIDTH OF NEIGHBORING SPACE. Sometimes it happens that, when a restoration is placed which fails to make contact, the occlusion is such that the teeth move to close the contact and at the same time one or more neighboring contacts may be opened by the movement. Thus the real cause of many slightly open contacts will be found upon a careful examination of other teeth in the neighborhood, or it may even be in the opposite arch. Figures 1388 and 1389 are of a case in which proximal restorations had been placed in the distal of the first bicuspid and mesial of the second bicuspid, without restoring the contact. As a result, the second bicuspid moved mesially, opening the contact between it and the

first molar. There was a slight pocket on the mesial side of the root of the first molar. The mesial surface of the first molar and distal of the second bicuspid were free from decay. The separation had occurred as a result of the flat restorations in the bicusps. These were removed and a separator was applied on several occasions to move the second bicuspid back into contact with the first molar, it being held there during the intervals with base-plate gutta-percha. Later, permanent restorations were made to re-establish normal conditions, as shown in Figure 1389. It was necessary to relieve the occlusion on the distal slopes of the cusps of the second bicuspid to compensate for the slight occlusal movement of the lower bicuspid which had occurred.

The loss of the mesial surface of a second molar by caries may result in a mesial movement of the tooth, thus permitting

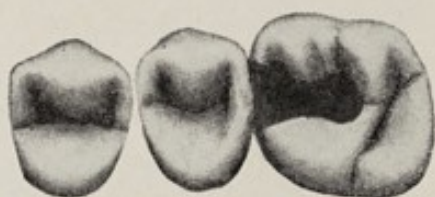


FIG. 1390.

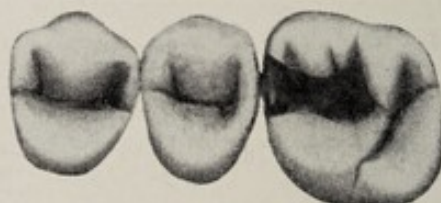


FIG. 1391.

FIGS 1390, 1391. Improper and proper contact restorations.

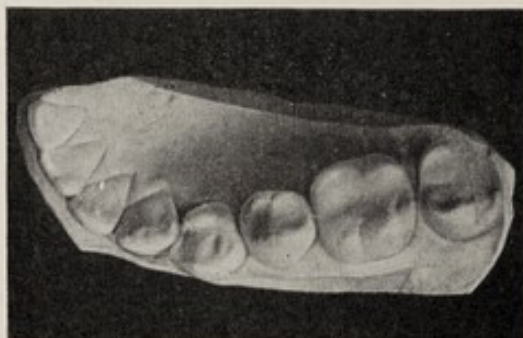


FIG. 1392A.



FIG. 1392B.

FIG. 1392. The distal convexity of the cuspid fits into a slight concavity in the first bicuspid.

food to leak through the contact between the distal of this tooth and the third molar. The restoration of the mesial surface should be so made as to restore both contacts.

Figures 1390 and 1391 illustrate a similar case, reported in Volume III. A mesio-occlusal amalgam restoration had been made in the upper first molar; evidently a matrix was used, but a separator was not used, and the contour of the tooth was not restored. The second bicuspid moved distally, opening the contact between it and the first bicuspid, and the septal tissue was inflamed. The treatment in this case consisted of doing what should have been done in the first instance; a separator was applied to move the second bicuspid back to its former position and a properly contoured restoration was placed in the first molar. The result is shown in Figure 1391.

GINGIVITIS DUE TO IMPROPER CONTACT OF THE TEETH.

ABNORMAL FORMS OF THE TEETH. Contacts which are more or less broad, frequently cause a gingivitis. Between the molar teeth, such contacts are not uncommon. Instead of presenting the normal convexity, which would give a point of contact between the teeth, the proximal surfaces may be much flattened, or the surface of one tooth may even present a slight concavity which fits more or less closely the convexity of the next tooth. As a ligature is passed through such a contact, it will drag for some distance, being held by the broad contact, instead of snapping through as it would in case of a normal contact. Shreds of stringy foods are occasionally caught between such teeth and, as time passes, this is likely to occur more frequently until the septal tissue is seriously injured.

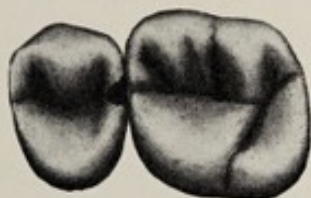


FIG. 1393.



FIG. 1394.

FIGS. 1393, 1394. Decay caused by flat contact; restoration after gaining separation.

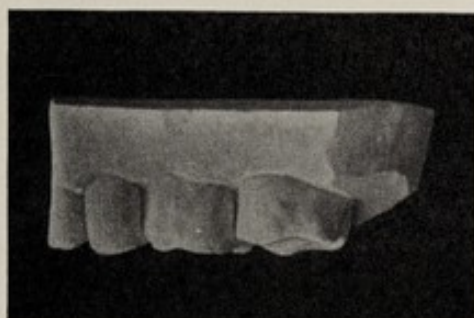


FIG. 1395A.

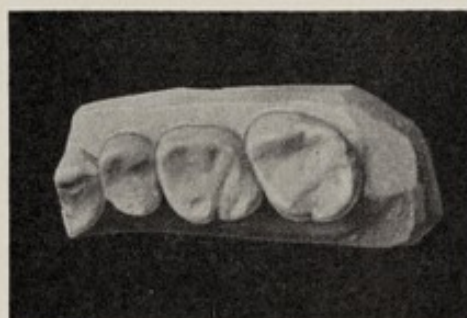


FIG. 1395B.

FIG. 1395. Plaster model of a case with a very broad flat contact between the upper first and second molars. The septal gingiva was injured by food impaction.

Figures 1392A and 1392B; a case in which the distal convexity of the lower cuspid lies in a slight concavity in the mesial surface of the first bicuspid. A silk floss dragged when the effort was made to carry it through the contact. Figure 1393 shows a flat contact between the upper second bicuspid and the first molar, with a cavity in the distal surface of the bicuspid. In this case the cavity was prepared for a gold inlay. At the appointment at which the inlay was to be set a Ferrier separator was placed and when sufficient space was gained, a prominent contact was soldered to the inlay and it was set with cement before the separator was removed. It will be noted in Figure 1394 that the embrasures are wider and the contact is in good form.

Figures 1395 A and B show a very broad flat contact between upper first and second molars.

If there is an inflammation of the septal gingiva due to too broad a contact of two teeth, several plans of treatment may be followed.

If the broad contact is due to the forms of the proximal surfaces of the teeth themselves, it may be practicable to trim the embrasure areas with thin stones and disks to more convex form and thus reduce the area of near approach about the point of contact. To do this it will generally be necessary to gain a little separation, preferably with a Ferrier separator, in order to provide room for the disks to approach the point of contact and yet leave the surface with a continuously smooth convexity. Figures 1396 and 1397 illustrate the change in the form of the proximal surfaces of a first permanent molar and a second temporary molar by widening the embrasures. The disk should not touch to contact point.

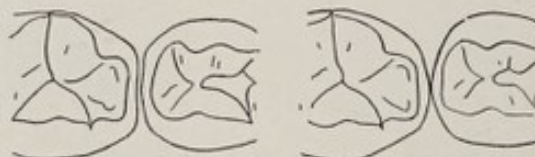


FIG. 1396.

FIG. 1397.

FIGS. 1396 and 1397 illustrate the widening of the embrasures between the lower second temporary molar and the first permanent molar.



FIG. 1398.



FIG. 1399.

FIGS. 1398 and 1399 illustrate the treatment by separation and a restoration in a case of a broad, flat contact.

Other cases should have the same treatment as cases of excessive proximal wear, in which it is usually necessary to cut a cavity in one tooth and make a restoration, using a separator to move the teeth sufficiently far apart to widen the embrasures, thus permitting the making of a prominent contact on the restoration. In such a case it would, as a rule, be desirable to make the proximal tooth more convex by disking the buccal and lingual embrasure areas. Figures 1398 and 1399 illustrate the treatment of a distal cavity in an upper second molar in a case in which the proximal surfaces of both teeth were very flat.

MALPOSITIONS OF TEETH. Contacts may be too broad on account of irregularities in positions of teeth. If a tooth is slightly rotated, or out of line, or if one may have elongated, as a result of the extraction of a tooth in the opposite arch, it may present a surface,

less convex than normal, in contact with one or both of the proximal teeth, resulting in the impaction of food.

In some of these cases the form of the tooth may be changed to improve the contact; in others it may be practical to prepare a cavity and place a restoration with a more prominent contact. It will be best not to do anything with some, other than give the patient instructions as to the best method of keeping the space clean.

EMBRASURES ABNORMALLY NARROW. In an occasional case the convexity of the proximal surfaces of adjoining teeth may be so slight that the embrasures will be abnormally narrow, while the point of contact is in fairly good form. Such cases are less likely to catch stringy foods than flat contacts, but are of importance for the reason that the embrasure areas of the enamel are not scoured in mastication, and such a condition promotes the occurrence of decay. Lodgment of minute particles of food debris within the embrasures on either side of the contact, due to the

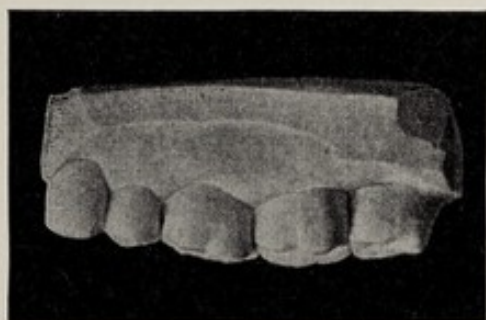


FIG. 1400A.

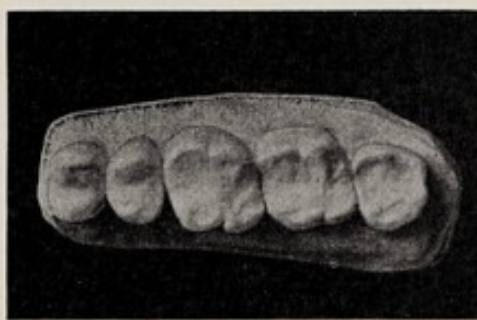


FIG. 1400B.

FIG. 1400. Plaster model of a case in which the contacts between the molar teeth were worn flat.

lack of natural cleaning, may also cause inflammation of the septal gingiva.

The treatment for these cases should be the same as for those with broad flat contacts. A separator should be placed and the embrasures should be widened with disks. Most of the cutting should be from the occlusal and buccal portions of the embrasure area, also from the occlusal and lingual portions. It should be gradually less as the crest of the septal gingiva is approached, also as the contact is approached. This widening will permit more food to pass through the embrasures, thus insuring greater safety for the enamel and better health of the gingivæ.

EXCESSIVE PROXIMAL WEAR. As a result of the slight buccolingual motion of the teeth in mastication, the enamel forming the contact points gradually wears, and the physiological tendency for the mesial movement of the teeth keeps them in close contact as the wear progresses, until eventually there will be a facet of considerable size on each tooth and the contact will be as

large as the facet. These occur oftenest in the spaces to the mesial or distal of the first molar, in the region where the heaviest chewing is done. Food will frequently be caught between these teeth, particularly in the mouths of middle-aged and older people, although in some cases the hold of the trans-septal fibers is so strong as to maintain the teeth in such tight contact that no impaction will occur. Teeth which show abrasion of their occlusal surfaces are more likely than others to also show considerable proximal wear. Figure 1400 illustrates a case in which there was extensive wear of the proximal surfaces of the molars. Figures 1401 and 1402 are photographic reproductions of two molars with large facets resulting from excessive proximal wear.

Contacts which have become flattened by excessive proximal wear often present a complicated problem by reason of the fact

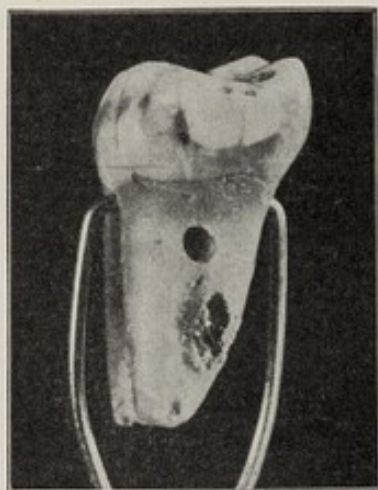


FIG. 1401.



FIG. 1402.

FIGS. 1401, 1402. Proximal wear of molar teeth. These teeth were extracted because of the destruction of the periodontal membranes by food impaction.

that all proximal surfaces in the bicuspid-molar regions are likely to be in the same condition, although there may be considerable differences in the extent of the wear and the impaction of food. Each interproximal space should be treated on the basis of the condition of the gingiva. In some cases the teeth are held in such close contact that food is not forced between them and the septal gingiva is not inflamed. If anything approaching a general readjustment is considered, which is seldom necessary, it should only be undertaken on a plan which will be carried out very gradually over a period of several years. It really involves the movement of all of the bicuspids and molars to allow for a slight widening of each embrasure. If one or more third molars are in place it may be desirable to remove them before the distal movement of the other teeth is begun.

In placing new restorations or replacing former operations in cases of excessive proximal wear, there should preferably be

corresponding movements of the teeth by coordinated operations in the upper and lower arches of the same side of the mouth, in order to cause the least possible disturbance of the occlusion. It will usually be found that the proximal surfaces of certain teeth may be ground to better form, and thus avoid or at least postpone the placing of restorations in these. In some, previous restorations can be replaced and in others new cavities must be prepared. Oftentimes the placing of one restoration with a prominent contact in the region will be sufficient to tighten all of the contacts of the neighboring teeth.

The fact should be kept in mind that the proximal wear of the teeth, in cases which receive no attention, will often shorten the distance around the arch, measured from one third molar to the other third molar on the buccal and labial side, by about one-third of an inch by the time a person is forty years of age. Of this wear, much the greater part occurs in the bicuspid and molar region, where the heaviest mastication is done. It is therefore important to begin the treatment of these cases early, and place a few restorations each year, regaining a little of the lost space each time by the use of the separator, thus preventing excessive mesial movement of the teeth.

The treatment of a case is reported in Volume III, which it seems worth while to mention here and refer to the illustrations, Figures 1109 and 1110. This patient was fifty years of age and the wear had not progressed sufficiently to cause more than slight inflammations of the gingivæ. The principal problem was the movement of the teeth, which was accomplished during a period of about six months. The technic of the gradual separation, using the Ferrier separators and base-plate gutta-percha is given in detail. Inlays were placed to establish and maintain the new contacts and contours.

One other case will be reported — a neglected case: A man about fifty years of age complained of pain and tenderness in the region of the upper molars, and the second molar was so tender to pressure as to suggest a beginning acute alveolar abscess. However, upon closer examination, it was discovered that the contact points of the first and second molars were worn flat and were standing a little apart, evidently due to inflammation in the tissues between their roots. In this case, a peridental explorer could be passed into a pocket on the mesial side of the root of the second molar almost to its apex, and nearly as far on the distal side of the first molar. The two teeth were extracted.

The condition was the result of wedging of food between the flattened contacts. If this had received attention when it first began to catch food, the detachment of the peridental membrane could have been avoided. In this mouth, there were four other septal spaces in which the tissues were shortened and inflamed.

RESTORATIONS AND CROWNS. The majority of inflammations due to improper contacts are caused by restorations or crowns with proximal surfaces which are too nearly flat. A restoration or a crown with a flat contact will catch and hold food debris and cause inflammation of the septal gingivæ in the same manner as will a flat contact of two teeth. Much too large a percentage of restorations and crowns are imperfect in their forms of proximal surface contour and contact. Gold inlays, the contacts of which may be of good form when placed, will wear flat in a few months in mouths in which the teeth are used vigorously, unless the alloy of gold is sufficiently hard to maintain its form.

Restorations and porcelain crowns can be trimmed to proper form by placing a separator for a moment to get room for the finishing, providing, in the case of crowns, that the gingival portion of the crown is not too prominent, as compared with the contour of the root. Gold crowns may be trimmed sufficiently in some cases, in others a cavity may be cut in the crown and a restoration made to re-establish the form of the tooth. It is always necessary to use a separator to hold the teeth apart when a flat restoration is trimmed to proper form.

DANGER OF DISTURBING THE OCCLUSION.

In all of the above the occlusion must be carefully watched. After each operation in which space has been gained by the use of a separator, the patient should be requested to close the teeth a number of times with lateral and protrusive movements while a piece of carbon paper is held between them to discover points of excessive stress. Also, careful watch should be made for movements of individual teeth when the occlusion is pressed hard. A finger held against the buccal surfaces of the teeth will often detect slight movements better than the eye.

The movement of the teeth necessary to restore proper contacts in one arch, may lead to a disturbance in the opposite arch, if care is not exercised. If any cusp strikes more noticeably than the others, as indicated by the carbon paper, enough should be ground off to relieve it. Otherwise the readjustment of the teeth which would occur within the next few days might result in the opening of some contact in the region, in either arch. It will usually be necessary to grind a little from some particular portion of the slope of the cusp, and the occlusion should then be examined again and again to see that this is properly relieved. This grinding need not disturb the cusp as a whole.

For example, if the lower bicuspid were slightly separated on account of a flat mesio-occlusal restoration in the first molar, and a separator should be placed between the second bicuspid and first molar, for the purpose of moving the second bicuspid hard against the first bicuspid and holding it there by building out a

sufficiently prominent contact on the first molar, it might be that the mesial movement of the second bicuspid would cause the mesial slopes of its cusps to strike too hard against the distal slopes of the cusps of the upper first bicuspid. If this were not corrected at once, the tendency would be for the upper first bicuspid to be moved mesially, and thus possibly weaken the contact between it and the upper second bicuspid. Or, the lower second bicuspid might be moved distally and thus reopen the contact between it and the lower first bicuspid. The least bit of grinding, which may usually be done with a disk or a fine stone from the mesial slopes of the cusps of lower second bicuspid or the distal slopes of the cusps of the upper first bicuspid should be sufficient.

It is necessary that this adjustment of the bite be made at the same appointment, during which the restoration is placed, to prevent disarrangement of the teeth during the next few days.

GINGIVITIS DUE TO DEVIATIONS FROM THE NORMAL SMOOTH CONTOUR OF TOOTH SURFACES.

SHARP EDGES OF CAVITIES. Decays of proximal, buccal and labial surfaces, which progress until some of the enamel rods have fallen away, cause inflammation whenever the broken edge of the enamel is under the margin of the gingiva. Decays in buccal and labial positions also indirectly cause a gingivitis about several adjacent teeth, by reason of the fact that the regions will not be properly cleaned artificially by the patient, on account of the sensitiveness of the decayed regions. Such an inflammation is usually of little consequence, if of short duration, but, if neglected, infection may occur and the peridental membrane may be involved.

IMPERFECT MARGINS OF RESTORATIONS AND CROWNS. All restorations of proximal surfaces, or gingival thirds of buccal and labial surfaces, the margins of which are not finished flush with the surface of the enamel, may cause gingivitis. If the restoration is overfull, the projecting edge will be a sufficient irritant to keep up a constant slight inflammation of the adjacent gingiva. If the cavity is not fully filled, the margin of the cavity wall may cause a similar irritation.

Inflammations are caused by crowns which do not closely fit the root end or which impinge on the attachment of the peridental membrane at the cemental line. Bandless crowns, which either project beyond the root at any point, or which fall short of being even with the root end, cause irritation in the same manner as do restorations which are too full or not full enough. The tissues are thus kept in a state of irritation for years and finally a pocket is formed, or the gingivæ recede, or both occur.

A bridge or partial denture may, by undue pressure, cause inflammation of the soft tissues, and bridges which do not actually press against the tissue, but are so constructed as to be neither self-cleansing nor easily cleaned artificially, will usually keep up an in-

flammation as a result of the accumulation and decomposition of food debris.

GINGIVITIS DUE TO LACK OF CLEANLINESS

LACK OF NATURAL CLEANING. The natural cleaning of the teeth and gingivæ by the full use of the teeth in mastication is of the utmost importance in preserving the health of the gingivæ. The scouring of the surfaces of both teeth and gingivæ by vigorous mastication prevents lodgments and accumulations, and this prevents the inflammation which would otherwise occur. Occasional cases present in which, on account of a sensitive or tender tooth, the patient has avoided for a time the use of one side of the mouth in chewing. The teeth and soft tissues of the used side will appear clean and healthy, while those of the unused side will, in marked contrast, exhibit teeth more or less coated over with lodgments of food debris along the margin of the inflamed gingivæ.

LACK OF ARTIFICIAL CLEANING. In many mouths in which the teeth are used vigorously in mastication there will be lodgments of food debris in those positions not well scoured by

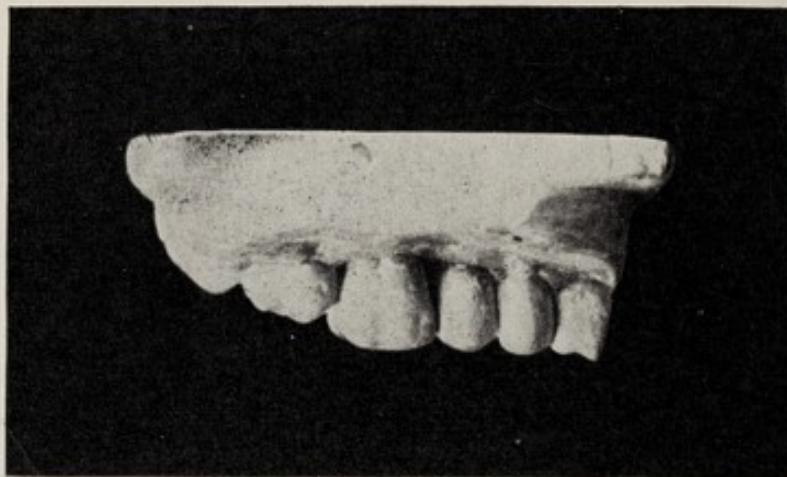


FIG. 1405. Plaster model of case in which the septal tissue between the second bicuspid and first molar had been injured by the use of a wooden toothpick.

the excursions of food, also in any other positions, which, on account of abnormalities of position or form of the teeth, or of the gum margins, afford opportunity for lodgments. Such places require to be cleaned artificially, and whenever this cleaning is not well done, the presence and decomposition of the lodgments may cause the soft tissues to become inflamed.

ERRORS IN CLEANING OPERATIONS. Occasional cases are seen in which serious injury has been done to the gingivæ by the misuse of one or another of the various things used in cleaning about the teeth. The dentist should be ever on the lookout for such inflammations, and he should impress his patients with the danger of such practices and urge greater care in the future.

There are two kinds of injuries caused by toothpicks: recession of the septal tissue by pressure, due to repeatedly pushing toothpicks of too large size through the interproximal space; and inflammations caused by the rough edges and splinters of poorly made wooden toothpicks. A case in which the septal tissue was injured with toothpicks is illustrated in Figure 1405.

A man of about thirty-five years had formed a habit of biting about an inch off the end of a wooden toothpick and pushing this piece through the various interproximal spaces with his tongue. He had been doing this many times each day for a year or more and had caused practically every septal tissue to recede, exposing the proximal surfaces of all of the teeth for some distance to the gingival of the points of contact. A suppuration had occurred between an upper second and third molar, destroying a considerable portion of the attachment of the periodontal membrane from the distal surface of the root of the second molar, and an acute infection occurred in the pocket. It was necessary to remove the tooth. In many other spaces the tissue was so badly injured that a full re-

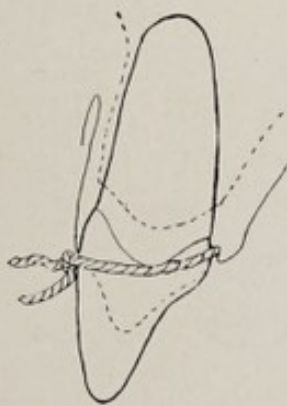


FIG. 1410.

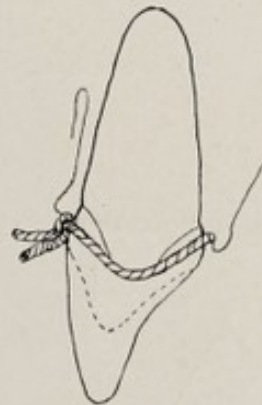


FIG. 1411.

FIGS. 1410 and 1411. Proper and improper methods of tying ligatures.

covery was out of the question. Many persons cause similar injuries in one or several spaces by habitually having a toothpick sticking between certain teeth.

There is danger to the septal tissues in the use of the rubber band or silk floss in cleaning the interproximal spaces, by the snapping of the band or floss against the soft tissue, when carried past the point of contact too suddenly. A single such injury is of no consequence, but frequent repetitions will soon cause a little recession, which will gradually become worse with continued irritations.

Injuries with the tooth-brush are less frequent than others, but occur often enough to require mention. The gingivæ may be injured by the use of too hard a brush, or by improper or too vigorous brushing. In both instances, the injury is most likely to be to the buccal or lingual portions of the septal tissue. In this the brush catches the margins of the gingivæ as they pass around

the angles of the teeth from the buccal or lingual into the interproximal spaces, and injures the gingivæ in these positions. This is done with the mesio-distal motion of the brush.

The gingivæ of the lingual surfaces of the upper incisors are very liable to be injured in biting by the pressure of foreign substances against them. Their position is more exposed to thrusts of food than any other of the gingivæ. Occasionally pieces of fish bones or stiff bristles from tooth brushes are forced into the gingivæ, or into the peridental membrane in the depth of the gingival crevice.

GINGIVITIS DUE TO ABUSE OF THE TISSUES BY DENTISTS IN OPERATING.

The dentist should use the utmost care to avoid injuries to the gingivæ in operating, and should always be certain that the gingivæ, and the gingival crevices especially, are clean, free from debris of any kind when each patient is dismissed. Certain injuries, occasionally caused by dentists, will be mentioned.



FIG. 1412. Injury with a ligature caused the formation of a pocket on the mesial side of the upper left central incisor and the teeth had separated.

INJURIES WITH LIGATURES. One of the worst forms of injury to the gingivæ is caused by the misuse of ligatures, particularly in tying them about the incisor teeth and cutting the attachment of the peridental membrane on their proximal surfaces. Figures 1213, 1214 and 1215 show the gingival lines on the proximal surfaces of two incisors and a cuspid, while Figure 1410 shows the proper method of tying a ligature around an incisor tooth. Figure 1411 illustrates the incorrect way to tie a ligature about an incisor tooth. If it is firmly drawn and pressed to the gingival as far as shown, the cutting of the attachment of the soft tissues on the proximal surfaces is inevitable. Figure 1412 is from a radiograph of a case in which a pus pocket on the mesial surface of an upper central incisor resulted from an injury in tying a ligature.

INJURIES WITH FINISHING INSTRUMENTS AND TAPES. In finishing restorations, the soft tissues are often unnecessarily injured with knife trimmers and finishing files, and more especially with finishing and polishing tapes. The various polishing disks and points used in the engine also cause a share of injuries. Many

similar injuries are caused by the misuse of strips and polishing devices used in cleaning and polishing the teeth. Whenever the soft tissues are injured in such operations, they should be thoroughly washed and massaged to remove all particles and to restore the circulation.

FAILURES TO REMOVE LIGATURES AND PIECES OF RUBBER DAM. An occasional case of injury to the gingivæ occurs from failure to remove a ligature; or a ring of rubber dam may be left encircling a tooth, if the septi between the teeth are not drawn to one side and cut before the rubber is removed. In either case, a serious infection of the peridental membrane is likely to result.

ESSENTIALS IN SUCCESSFUL MANAGEMENT OF GINGIVITIS.

CAREFUL STUDY OF CASES. The successful treatment for the prevention or cure of the cases of gingivitis which are constantly presenting, involves the more careful study by the profession of all of these slight inflammations. The discovery of each region of inflammation should lead to the immediate investigation of the cause and to the operation necessary for its correction. By following this plan, each operator will soon come to have a better understanding of the results obtainable in treatment when the greatest attention possible is given to every detail.

In this the most rigid rules of looking after what is now regarded as the minor details of practice will be necessary. Every injury to the gingivæ should have a place in the record of examinations. The treatment of these and the outcome of each case, as determined by later examinations, should be recorded. In this way records will be accumulated which will be of great practical value and many serious cases of disease will be avoided.

MOUTH DIVIDED INTO SIX REGIONS IN MAINTAINING CONTACTS. In carrying out a program for the best protection of the septal gingivæ, the mouth should be divided into six regions—three in each arch. The anterior region includes the six front teeth, the lateral regions include the bicuspid and molars on either side. Whenever a restoration is to be placed or a contact reestablished, each region should be considered as a unit, and all of the other contacts of the particular region should be noted in order that they may, if desirable and the conditions will permit, be tightened by increasing slightly the width of the space where the operation is to be performed. In fact the normal wear of the proximal surfaces of the teeth should be ever in mind and a little space should be gained in every operation for adults to compensate for this wear. A number of examples are cited in the preceding pages, in which several contacts were tightened at a single operation and in one case four weak or open contacts were made tight by placing a mesio-occlusal inlay in a first molar.

In cases in which a number of restorations are to be made in one region, it will usually be best to leave the one nearest the center

of the region to be performed last, as it offers the opportunity to increase the tension of all of the contacts of the region. For example, in a bicuspid-molar region, a mesio-occlusal restoration in the first molar may generally be the means of taking up any slack in the pressures of several contacts. It is always possible to determine in advance just what can be accomplished in this way, by testing the contacts first. This is done by placing a separator in the position in which the restoration is to be made and noting the increased tightness of the neighboring contacts as a result of the moderate adjustment of the instrument. In many cases a slight prying motion with a beaver tailed burnisher in the interproximal space will accomplish the same purpose.

AN EXACT METHOD OF SEPARATION ESSENTIAL TO SUCCESS. To-day the principal necessity for separating the teeth is to restore proper contacts. With present methods of cavity preparation, separation for convenience of access is generally unnecessary for restorations in the posterior teeth, and only occasionally in the anterior teeth. Therefore, only a little movement of the teeth is necessary—just enough to permit of trimming and polishing and still leave a proper contact. It is understood that if the teeth have moved together more closely than they should normally be, additional separation is necessary.

It is not within the scope of this volume to do more than emphasize the imperative need of serious study of the best methods of proper contact restorations. This matter is discussed and illustrated in Volumes II and III. The recently designed Ferrier separator which is a refinement of the separator invented by the late Dr. Stafford C. Perry, is the most satisfactory instrument for this purpose on the market today. It is illustrated in Volume II, pages 242 and 243, also in connection with a number of operations in Volume III, pages, 155, 164, 196, 198, 214, 254 and 262. There are six instruments in the set and they may be so applied as not to injure the gingivæ. This separator, or some similar appliance having four jaws which may be set against the teeth without impinging on the soft tissues, should be used for practically every proximal restoration of gold foil or amalgam. In connection with the placing of amalgam restorations, it should be applied a second time for the polishing. It is also indispensable in the placing of proximo-occlusal gold inlays in all cases in which it is desirable to tighten several contacts with one operation. Satisfactory contact restorations can not be made otherwise.

The study of contact forms of both teeth and restorations should be a constant one by every dentist. In the examination of each mouth every contact should be tested and a record made of those which are not normal. If the contact is not right, there will usually be an inflammation of the septal tissue which can not recover until the faulty contact is corrected. In this constant care of contacts lies, in considerable measure, the secret of the prevention of periodontal disease.

Pressure Pericementitis

BIBLIOGRAPHY ON INVESTING TISSUES PAGE 265

ILLUSTRATIONS: FIGURES 1415-1442.

THE term *pressure pericementitis* is applied to an inflammation of the pericemental structures resulting from a lack of balance between the masticating force and its direction on the one hand and the resistance of the supporting structures on the other.

This is therefore a mechanical injury, which may and often does occur in the absence of infection. There may be an associated infection, or infection may occur subsequent to the injury. One of the important considerations is that pressure pericementitis results from a particular type of trauma and not from infection.

In this discussion the variations to be considered are those of particular teeth and their supporting structures; not variations in the bite strength as a whole.

Attention has been called to the rather elaborate arrangement of the principal fibers of the periodontal membrane, which permits the teeth to move slightly within their respective sockets, in response to force exerted in various directions during movements of the mandible, and to return to their former positions when the tension of the muscles of mastication is relaxed. The force may be applied in the direction of the long axis of the tooth, or at a slight or considerable angle to the long axis, thus causing the tooth to be momentarily depressed or to be slightly tipped in its socket. In the tipping movement the crown is moved laterally as a result of pressure on the inclined plane of a cusp (or cusps), while the apex of the root moves in the opposite direction, the center of rotation for the movement being somewhere between the horizontal and apical fiber groups. However, in what may be termed the functional range of movements in any direction, the adjustment of the lengths of the fibers is such that the cementum of the root does not come into contact with the bone of the alveolar process, nor unduly compress the periodontal membrane.

The force with which the teeth are pressed together is normally equaled by the resistance of the supporting structures. The strength of the muscles of mastication is greater than that of the supporting mechanism of the teeth, although the latter, when in normal health, possess ample residual strength beyond that required in mastication. From the tests of the strength of the bite made with the gnathodynamometer, reported in Volume I, page 208, it is apparent that the force exerted by the muscles of mastication is limited by pain felt in the periodontal membrane. In this connection, attention is called to Noyes' statement, quoted in dis-

cussing the functions of the principal fibers of the peridental membrane, that "the connective tissues increase in strength to meet the demands of use, in response to mechanical conditions and stimuli". The strength of the peridental membrane and of the bone of the alveolar process is therefore the result of the force regularly used in mastication, provided the physical condition of the patient is such as to enable the tissues to respond to the stimuli of use.

In view of the fact that practically every denture, which would ordinarily be spoken of as normal, has many minor variations from the truly normal in the positions, forms and occlusal relations of the teeth, there must occur compensating changes in the supporting structures in order to sustain the stresses produced in the particular regions under what may be termed the "normal" conditions of mastication for the individual.

A pressure pericementitis occurs when conditions are such as to cause or permit a tooth to be moved in its socket beyond the functional limit. The force may be of such magnitude and direction that the supporting structures are unable to respond with sufficient vigor in compensatory strengthening of their structure. On the other hand, without increase in the force, the resistance of the supporting structures may be reduced as a result of ill health, malnutrition or local injury.

If such a lack of balance exists, and the force is applied to a tooth in approximately the direction of its long axis, the tooth will be depressed beyond its functional range and an inflammation of the periapical tissues may result.

If such a lack of balance exists, and the direction of the force and the inclination of the surface to which it is applied are such that the tooth is tipped in its socket beyond the functional range, inflammation is likely to occur in the supporting structures in the region of the crest of the alveolar process.

The tipping movement compresses the peridental membrane between the tooth and the crestal portion of the alveolar process on the side toward which the crown is tipped, with corresponding straightening of the fibers on the opposite side near the crest. These are called regions of pressure and of traction respectively. If the center of rotation for the tipping movement is in the mid-section of the root, the apex will move in the opposite direction from the crown, creating regions of pressure and traction corresponding to, but on opposite sides of the root from those at the position of the crest of the bone.

When, under similar conditions, pressure is applied to a multi-rooted tooth in such manner as to tip it in its socket—to move the crown buccally, for example, the tendency is for resorption of the bone of the crest of the process to occur on the buccal side, with straightening of the fibers on the lingual side, also to lift the apex of the lingual root in its socket. The center of rotation in this case is generally located at some point between the roots.

STUDIES OF THE DISTRIBUTION OF FORCE IN MASTICATION.

Maxwell* in a very comprehensive study of the fundamental truths underlying occlusion devotes a chapter to the distribution of force through the medium of occluding contacts, which is of particular interest in its explanation of the conditions which may result in pressure pericementitis. It includes the laws of force as they apply to the leverages involved, the "moments of force" as they apply during occluding mandibular movements, and particularly to individual tooth movements with associated compression and traction of the peridental membrane.

A brief review of certain essential facts that are related to inflammations of the supporting structures of the teeth, which occur as a result of unequal distribution of masticating stresses, is presented in the following pages, omitting much of the mathematical data. These studies are primarily concerned with mechanical problems, which for the moment necessarily ignore the possibilities of compensatory strengthening of the supporting structures. However, they do serve to explain the occurrence of pressure pericementitis in cases in which the supporting structures are unable to sustain the force. These studies deal with conditions with which the general practitioner of dentistry is daily confronted.

JUST AND EQUITABLE DISTRIBUTION OF FORCE. Maxwell states that normal arrangements of the teeth and the normal relation of the dentures result, through cusp interdigitation in lateral excursions of the mandible, as well as in the functional range from protrusive to centric, in a *just and equitable distribution of masticatory force*. This signifies a just and equitable distribution of pressures and stresses in the peridental membranes of all of the teeth. Cusp interference in either lateral-to-centric or protrusive-to-centric movements may result in injury to certain of the peridental structures and possibly to disuse atrophy of others.

Attention is called to the fact that Maxwell uses the word *equitable* in referring to the distribution of force. The term *equal distribution of force* may be properly applied only to bilateral equivalents during the protrusive-to-centric range. There is not an equal distribution of force in the lateral occluding ranges.

Two schematic drawings are introduced to illustrate the meaning of "a just and equitable distribution of force." In these no attempt is made to portray actual mouth conditions or to mention actual forces. In Figure 1415 the upper and lower rectangles, designated by letters, are considered to be the upper and lower molars and bicuspid, supported by springs which represent the peridental membranes in their ability to sustain the stresses of mastication. The temporo-mandibular joint is indicated at A, although it should be clearly understood that the fulcrum of movement may be considerably removed from this point. Masticatory

* The Contact Occluding Sphere, George H. Maxwell. Limited mimeographed edition. Chicago, 1934. This consists of 126 closely typewritten pages with 88 illustrations.

force of 200 units is represented by the large coil spring. When the rectangles are brought into occlusion, the force of 200 units is equaled by the total of the stresses on the ten small springs, with a proportional increase antero-posteriorly, as indicated.

In Figure 1416 it is presumed that two other rectangles of longer axial dimension are inserted at B and C. This represents a malocclusion which places 125 units of force on one pair of rectangles and 75 units on the other pair. Maxwell states that the figures are not correct; they are simply used as illustrations. Here is an unjust and unequitable distribution of force—an intolerable force is applied to four teeth, while the others have lost occlusal contact and would suffer from disuse atrophy if the condition were permitted to continue. This is cited as an extreme example; the reactions of the tissues which may occur will be discussed later.

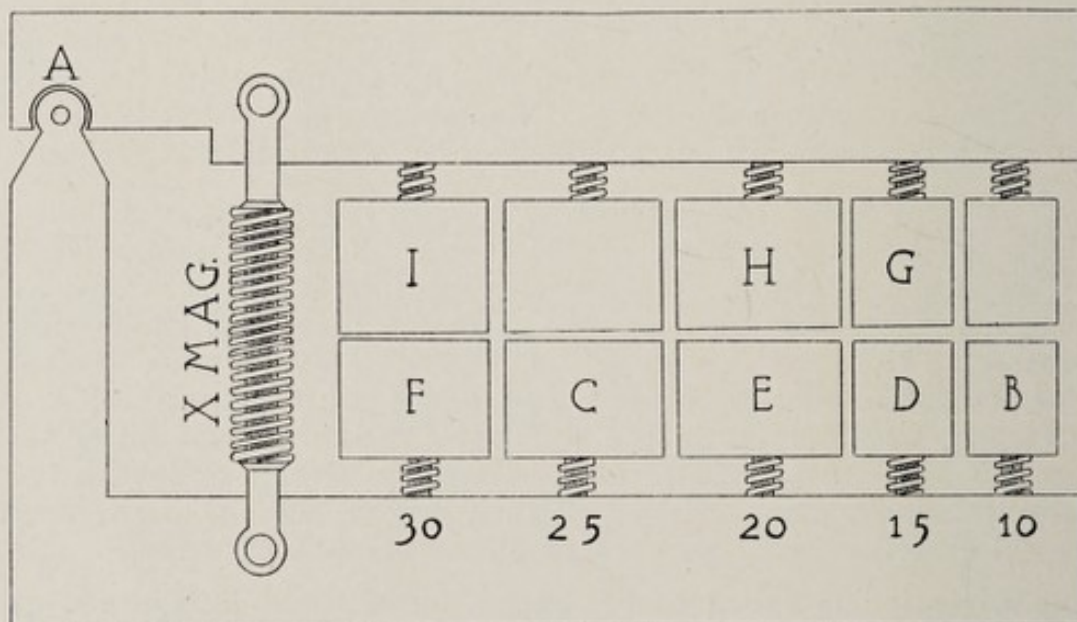


FIG. 1415. Drawing illustrating the distribution of force upon the teeth in normal occlusion. Maxwell.

In considering the leverages that exist for the individual teeth, each of which has a resistance arm of different length, it is necessary to think of the relation of these to the magnitude of the force applied. The larger the number of teeth to which a force is applied, the smaller will be the portion distributed to each, and the reverse is also true. If a single contact of opposing teeth exists there is no division of the effective force, which may be entirely too great in proportion to the periodontal areas involved.

Consideration should also be given to the fact that the masticatory mechanism in man, while closely similar to the carnivora in the forms of the teeth, is adapted for the lateral mandibular

movements of the herbivora. For this reason, the cusps of the teeth in man are generally shorter than those of the carnivora, and their inclined planes control the direction of lateral movements with the teeth in pressure contact. The pitch of the lateral movement becomes less as the cusps wear, and therefore becomes less and less with advancing years. In childhood this is an important factor in determining and maintaining the width of the arch, for the reason that the arch width, the inclinations of the cusps and the lateral excursions of the mandible are interrelated.

THE MOMENT OF FORCE. This term refers to the turning or tipping effect on a tooth as it is brought in pressure contact with its fellow, or fellows, of the opposite arch. Injury to the periodontal membrane is not caused directly by the masticatory force,

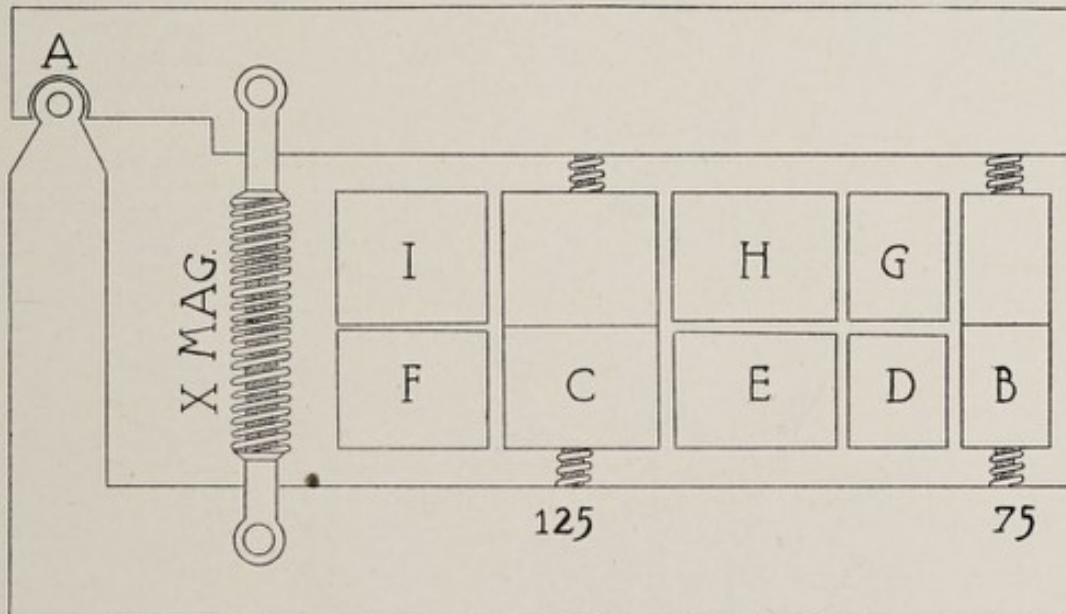


FIG. 1416. Drawing illustrating a case of malocclusion with uneven distribution of force. Maxwell.

but by its application to individual teeth in the form of tipping force. This is illustrated with a bicuspid in Figure 1417 and may be explained sufficiently for the purpose of this presentation without entering into all of the mathematical details. If the cusp of an approaching tooth is applied at A, in the direction BA, the resultant of this force is to tip the tooth in the direction CA. This resultant is due to the relation of the direction of the force to the inclination of the occlusal surface of the tooth at A. This represents extreme functional lateral occlusion. The moment of force is concerned with both the amount or magnitude of the force and the angle of its application. In this case, the tipping force would bring

excessive pressure on the crest of the buccal alveolar process at Y and also on the lingual side of the root near the apex at F. If the same force were exerted at the point A' and in the direction parallel to that at A, it will be readily understood that the tipping effect would be very slight. It may also be observed that the tipping effect of the force applied at A will become less and less as a cusp is worn more and more.

Whenever the force exerted at A is too great for the resistance that may be offered at Y, a pressure pericementitis will result at Y and possibly at F, while there will be traction on the periodontal membrane at X and Z, as will be illustrated by photomicrographs in

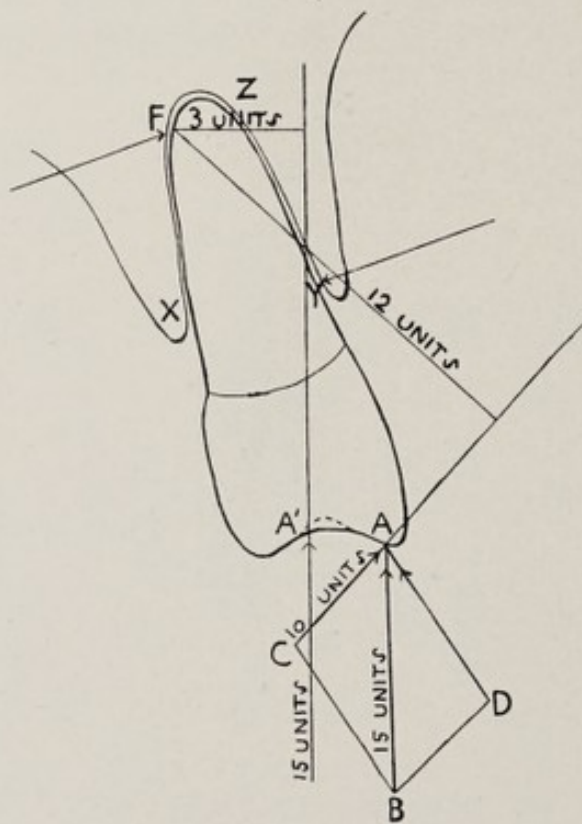


FIG. 1417.



FIG. 1418.

FIG. 1417. Diagram illustrating the "moment of force." *Maxwell.*

FIG. 1418. Diagram illustrating wear of the cusps of the bicuspid and molars. *Maxwell.*

the following pages. However, the same force at A' would be resisted without harm to the tissues. If a portion of the crest of the bone at Y should be resorbed as a result of the pressure, the leverage will be greater and additional pressure will be exerted at Y, as a result of the continued application of the same force at A. This principle is involved in injuries to the supporting structures by the tipping force in all cases.

BICUSPIDS AND MOLARS. The wear of the cusps of the bicuspid and molars is illustrated in Figure 1418. Attention is first called

to the fact that the buccal slopes of the upper buccal cusps and the lingual slopes of the lower lingual cusps receive no wear, because they do not occlude. The upper buccal cusps are in occlusion only on their lingual slopes and are shortened only as the wear of the lingual slopes includes the points of the cusps. The lower lingual cusps are similarly in occlusion only on their buccal slopes. The buccal cusps of the lower bicuspid and molars and the lingual cusps of the upper molars are worn most, because their lingual and buccal slopes are both subjected to wear, and the wear of each slope contributes to the shortening of the cusp.

Figure 1419 illustrates a case of excessive abrasion of the molar teeth. In this a destructive moment of force prevails in both

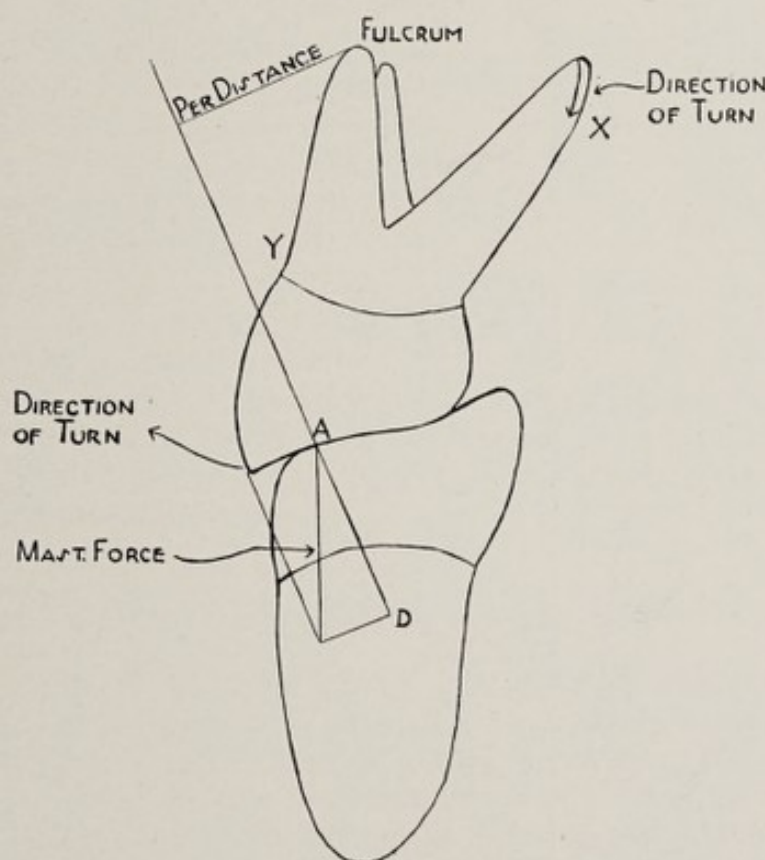


FIG. 1419. Drawing illustrating the tipping force on an upper molar. Maxwell.

lateral and centric occlusion. The direction of the force is BA, while the moment of force or tipping force applied to the upper molar, is in the direction of DA. The fulcrum is in the region of the apices of the buccal roots, and a compressive force is exerted on the periodontal membrane at the crest of the buccal alveolar process at Y. There is also pressure at X, with the tendency to lift the lingual root from its socket. It should also be noted that the buccal movement of the crown of the upper molar (presuming it to be a first molar) is likely to open its contacts with the second bicuspid and second molar. The septal tissues would then also be subject to inflammation from food impaction.

The tendency in all such cases is to tip the lower molar crown to the lingual and, with the lingual crest of the alveolar process

as a fulcrum, the tendency would be to move the apex of the root buccally.

Figure 1422 illustrates an extreme abrasion as a result of the unusual position of the upper second molar. The lower molar stands vertically, its axial dimension being parallel to the direction of the masticatory force, as indicated by the lines A and A. As the abrasion progressed the lingual cusp of the upper molar fitted itself into the central fossa of the lower second molar, so that the lingual surface of the upper molar is in occlusion. The tipping force is

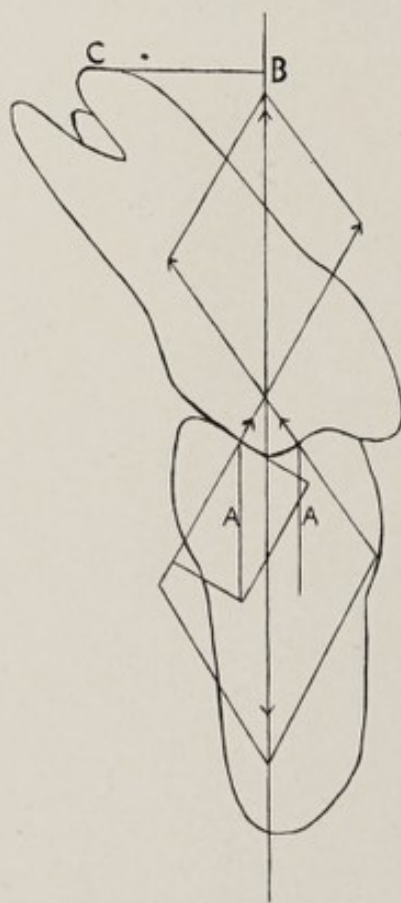


FIG. 1422.

FIG. 1422. Drawing illustrating how opposing teeth are affected differently, although subjected to the same magnitude of force. *Maxwell.*

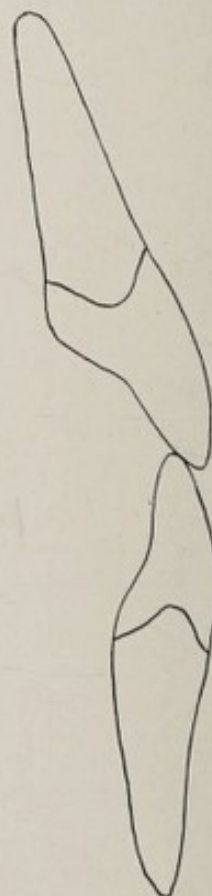


FIG. 1423.

FIG. 1423. Relation of upper and lower incisors. *Maxwell.*

represented by the line CB, in relation to the axis of the upper molar, the crown of which will be moved upward in the disto-buccal direction. It will be noted that there is no tendency for movement of the crown of the lower molar. "This figure demonstrates why opponents, although subjected to the same magnitude of force, are differently affected."

Mesial and distal movements of bicuspid and molars occur, with associated opening of contacts, as a result of more or less similar conditions to those illustrated for lateral movements of the

teeth. Mesial or distal movements are less likely to occur than buccal or lingual movements, and are in considerable measure limited when all of the teeth are present. Such movements may result from malpositions, malrelations or malforms of the teeth.

THE INCISOR REGION. As illustrated in Figure 1423, the force resultant in the incisor region tends to move the upper teeth labially and the lower teeth lingually. The lower incisors resist lingual movement largely as a result of their positions in the form of an arch. The arch arrangement is of no value in preventing the labial movement of the upper incisors, which is a matter of first importance in the consideration of the diseases of the supporting structures. Here the almost continuously acting force exerted by the lips and other soft tissue structures serves to maintain the teeth in their proper position. The labial movement of the upper incisors is most frequently initiated by inflammation of their lingual gingivæ and peridental membranes. In such cases the upper teeth may move completely away from possible contact with the lowers, yet the movement may be furthered by the pressure of food against the upper teeth in biting.

In cases in which the wear of the bicuspid and molars is out of proportion to that of the incisors, or in which a sufficient number of these teeth have been lost, the bite is shorter or the mandible is thrust farther forward, causing excessive pressure by the lower incisors on the lingual surfaces of the upper incisors and may be effective in causing their labial movement, with separation of the proximal contacts.

STUDIES OF THE TISSUE REACTIONS TO ORTHODONTIC FORCE.

In view of the fact that the forces used in orthodontic treatment are in some measure related to those forces which are effective in causing certain types of pressure pericementitis, it seems desirable to refer to investigations relative to the changes which occur in the supporting structures as a result of orthodontic force. This is done with due appreciation of the fact that orthodontic service is performed for children, at a time when the changes in the bone are most active, while the general dental practitioner is primarily concerned with pressure pericementitis in the mouths of adults, in which the reaction of the bone is comparatively slow.

In orthodontia, the force may be applied continuously over a considerable period of time, or there may be shorter periods during which force is applied, with intervals of rest; in pressure pericementitis the pressure is intermittent in that it is applied on each occasion when the teeth are brought together in pressure contact, with rest periods between. In the majority of cases of orthodontia, it might be said that the pressure is fairly continuous during the general program of moving the teeth, with stabilization afterward to permit the reorganization and building of bone about the teeth in their new positions. In pressure pericementitis, the pressure is

always intermittent, and nature has excellent opportunity to maintain and strengthen the supporting structures in response to the increased demand.

There are but two features of orthodontic treatment that are of interest in the study of tissue changes in pressure pericementitis: (1) the effect upon and the reactions of the supporting structures, particularly in the region of compression at the crest of the alveolar process, in cases in which the force is so applied that it tends to tip the tooth within its socket; (2) the reaction of the bone in both the pressure and traction regions after tooth movement is completed and stay appliances are placed. In the photomicrographs which are reproduced the changes in the two conditions appear to be very similar.

The most outstanding work in this field has been reported by Oppenheim* of Vienna during recent years. The last series of studies, published in *The Angle Orthodontist*, were all made on the teeth of young persons, from 13 to 15 years of age. Dr. Oppenheim states that these experiments were performed under the same con-

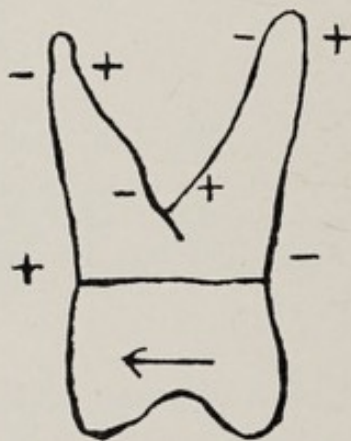


FIG. 1424. Effect on the peridental membrane of tipping force applied to the crown of a tooth. Oppenheim.

ditions as prevail in orthodontic practice. Presumably there might be some question raised on this point by orthodontists, in view of the fact that different methods are used. The experiments generally covered periods of several months, and the teeth were then extracted, removing sufficient of the adjacent supporting structures to permit microscopic studies of the tissue changes.

A few selected illustrations will be reproduced, together with abstracts of several statements in Oppenheim's summary, which was published in the January and April, 1936, numbers of *The Angle Orthodontist*. This discussion will be confined closely to the two factors already mentioned, which are of interest in relation to the changes occurring in pressure pericementitis. In the

* Bone Changes During Tooth Movement. *International Journal of Orthodontia, Oral Surgery & Radiography*, Vol. 16, 1930, p. 535.

The Crisis in Orthodontia. *International Journal of Orthodontia & Dentistry for Children*, Vol. 19, 1933, p. 1201, 1920; Vol. 20, 1934, p. 18, 137, 250, 331, 461, 542, 639, 759, 964, 1072, 1178; Vol. 21, 1935, p. 50, 153, 243, 333, 445, 531, 621, 733.

Biological Orthodontic Therapy and Reality. *The Angle Orthodontist*, Vol. V, 1935, p. 159, 233; Vol. 6, 1936, p. 5, 69.

early application of a force which tends to tip the tooth within its socket, the crown of the tooth is moved toward the crest of the bone in one direction, compressing the peridental membrane, and the apex of the root compresses the peridental membrane on the opposite side of the root. These are called regions of *pressure*. At the same time the peridental membrane fibers are pulled taught in the region of the crest of the bone on the side opposite the pressure, and the same condition prevails near the apex of the root on the side of the socket from which the apex moves. These are called regions of *traction*. See Figure 1424, a sketch of a molar tooth, on which the arrow indicates the direction of movement, plus signs the regions of pressure and minus signs the regions of traction.



FIG. 1425. Tipping force with orthodontic appliance; pressure side. B, bone; ocl, osteoclasts; ac, alveolar crest; Ps, periodontal space; C, cementum; C2, islands of normal cementum; cK, cementoclasts; ml, line of measure. *Oppenheim*.

Bone reacts to increased pressure by resorption. This creates room for the movement of the tooth. Resorption is always most advanced at the alveolar margin and gradually causes an irregular diminution in the height of the process. According to the length of time that has elapsed between the last renewal of force and the

extraction of the tooth on which the experiment is performed, the bone (especially the alveolar border) shows signs of more or less regeneration. On the traction side, bone is formed as a result of the pull upon the periodontal fibers.

Figure 1425 (human) shows the labial or pressure side at the level of the alveolar crest. Active resorption of both bone, *ocl.*, and cementum, *ck.*, is in progress. The crest of the bone is near the bottom of the illustration. In Figure 1426, on the traction side of the same tooth, new bone, *ost.*, is being built near the crest "in irregular thick layers and also in the shape of short spines, which are densely beset by osteoblastic rows."



FIG. 1426. Tipping force with orthodontic appliance; traction side. B, bone; ost, osteoid (newly formed bone); Ps, periodontal space; C, cementum; hem, hemorrhage; ml, line of measure. Oppenheim.

Figure 1427 shows the periodontal membrane and bone on the labial or pressure side in an experiment on a dog reported by Oppenheim in 1930*. The periodontal membrane is indicated by the letter *g*. In this case, three weeks elapsed from the time pressure was last applied until the dog was killed. The repair of the

* International Journal Orthodontia, Vol. XVI, 1930, p. 549.

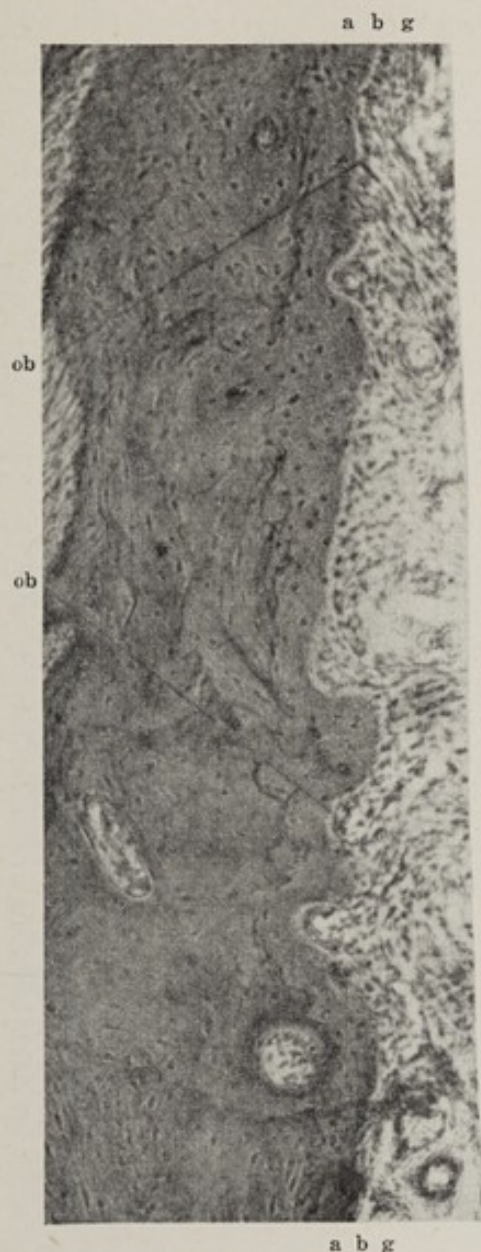


FIG. 1427.



FIG. 1428.

FIG. 1427. Rebuilding of bone on the pressure side during rest period after orthodontic force was discontinued. The new bone extends from the top to the bottom of the illustration between a and b; the periodontal membrane is marked g; osteoblasts may be seen at ob and ob. *Oppenheim*.

FIG. 1428. The same case on the traction side. The periodontal membrane is at g. The new bone formed as a result of traction on the periodontal membrane is clearly shown. *Oppenheim*.

bone on the pressure side is very clearly shown from the top to the bottom of the illustration, between the letters *a* and *b*. The surface of this bone is lined with osteoblasts, see *ob* and *ob*. Figure 1428 shows the periodontal membrane and bone on the lingual or traction side of the same tooth. The periodontal membrane is indicated by *g*. The strip of new bone, formed in response to the traction on the fibers of the periodontal membrane is easily distinguished.

As a general rule it may be said that cementum resorptions are healed promptly with a deposit of secondary cementum, as soon as the irritation which caused the resorption is eliminated.

Oppenheim considers cementum hypertrophy a functionally

conditioned protective and reparative measure to reduce the width of the peridental space.

Another valuable contribution to the general subject of pressures which tip the teeth in their sockets has been made by O. H. Stuteville* in a very carefully conducted series of studies, in which accurately measured force was applied, in selected cases, to teeth of persons from twelve to fifteen years of age. When the period of the experiment had terminated, the teeth are removed together with a sufficient amount of the supporting structures to give an accurate picture of the tissue reactions. Four photomicrographs are reproduced in the accompanying illustrations.

Figures 1429 and 1430 show the changes which take place in the supporting structures on the pressure and traction sides re-

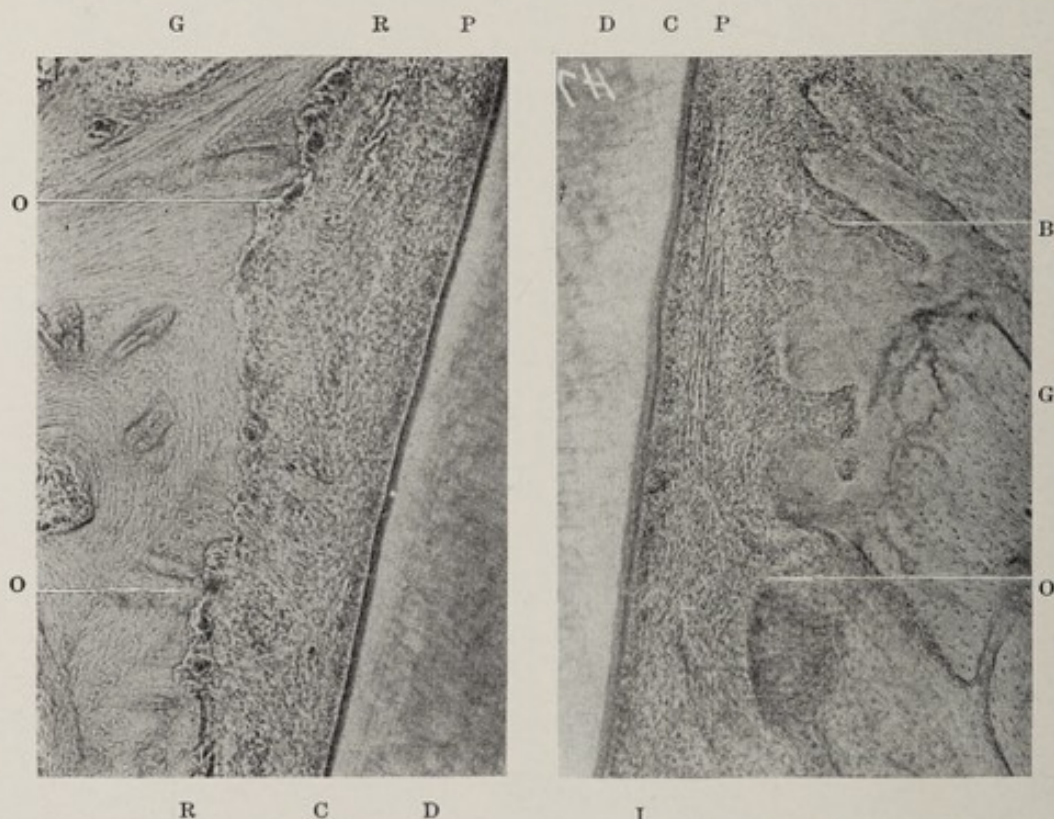


FIG. 1429.

FIG. 1430.

FIG. 1429. Absorption of bone on the pressure side during application of orthodontic force. Stuteville.

FIG. 1430. Building of new bone on the traction side during application of orthodontic force. Stuteville.

spectively of the root, when mild pressure is maintained for a time, without tipping the tooth sufficiently to make pressure contact against the bone. The tooth is an upper first bicuspid in the mouth of a boy fourteen years of age.

Figure 1429 shows the peridental membrane and bone on the buccal or pressure side of the root near the crest of the process. The tooth was moved buccally by an auxillary spring attached to a lingual arch. The spring was adjusted to exert a force of 100 g.

* Investigations to form the basis of a thesis, in part fulfillment of requirements for a master's degree, Northwestern University Dental School.

and was still active at the time of removal at the end of twenty-nine days.

There is osteoclastic activity on the peridental membrane surface of the alveolar process. There were no resorbed regions in the cementum. The region of resorption in the bone extends the full length of the illustration from R to R; the osteoclasts may be seen at o, o; the bone is indicated by G; peridental membrane P; cementum C and dentin D.

Figure 1430 shows the lingual or traction side at the position of the crest of the bone. New bone spicules are arranged parallel to the line of force. Due to the fact that the tipping movement caused the lingual root to be elevated within its alveolus, the lingual side of the crown of this root was correspondingly raised and the

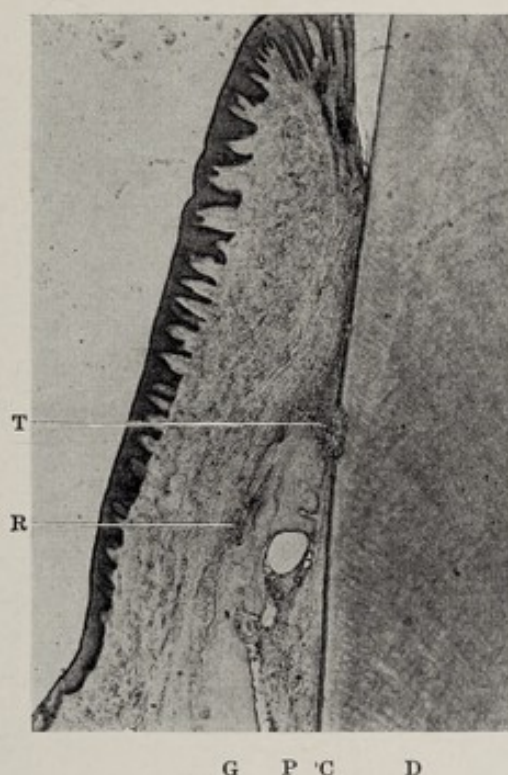


FIG. 1431.



FIG. 1432.

FIG. 1431. Pericementitis caused by orthodontic force sufficiently strong to press tooth against the crest of the alveolar process. *Stuteville.*

FIG. 1432. Repair on the pressure side during rest period in a case similar to that shown in Fig. 1431. The bone which had been resorbed is being rebuilt and the resorption of the cementum is being replaced with secondary cementum. *Stuteville.*

traction on the fibers of the alveolar crest group caused the crest of the process to be built considerably higher. The line of demarkation between the normal alveolar process and the bone newly formed as a result of the pull on the fibers of the peridental membrane is very clearly shown. The normal bone is marked G; the new bone B. Osteoblasts are shown at o, the peridental membrane P; the cementum C, and the dentin D.

Figure 1431 illustrates the pericementitis caused by a force sufficiently strong to press the tooth against the crest of the alveolar process. This is an upper first bicuspid from the mouth of a girl

fifteen years of age. The tooth was moved buccally by a finger spring attached to a lingual arch. The spring exerted a force of 100 g. at the beginning of the experiment and was still active when the tooth was extracted at the end of twenty-nine days. The tooth is pressed against the crest of the buccal process. The peridental membrane is necrotic in this region. There is an undermining resorption involving both the bone and the surface of the root at the point T. There is also an undermining resorption of the bone on its outer aspect, apical to the necrotic area of the peridental membrane at R. The normal bone is marked G, the peridental membrane P, the cementum C and the dentin D.

Figure 1432 illustrates the repair that was in progress in the supporting structures on the pressure side during the rest period, after resorptions of bone and cementum had been caused by pressure. This shows the tissues in the region of the crest of bone. The tooth is an upper first bicuspid of a girl fourteen years of age. This tooth was ligated to a 19 gauge labial arch which exerted a force of 120 to 150 g. actively throughout 0.2 of a mm. The force was reactivated six times at 14 day intervals. Twenty-eight days elapsed between the last adjustment and the extraction. The normal width of the peridental membrane space is being reestablished by the deposition of secondary cementum on the resorbed region of the root surface at S, and by the building in of new bone on the peridental membrane surface of the buccal process at B. The normal bone is marked G, the peridental membrane P, the cementum C and the dentin D.

ETIOLOGY OF PRESSURE PERICEMENTITIS.

LOWERED RESISTANCE. An important factor is the condition of the supporting structures as to health and vital resistance. Their resistance is lowered by lack of proper nutritional balance or by malnutrition in any form. These tissues become inflamed as a result of many systemic conditions, such as those caused by the metallic poisons, diseases of the blood forming organs and at least several chronic diseases, as diabetes, tuberculosis, syphilis, etc. Under normal conditions of health, the supporting structures are expected to meet gradually increasing stresses, as has been mentioned, but when their resistance is low they may not withstand even the normal stresses to which they have been accustomed.

ABNORMAL WEAR. The conditions have been presented by which certain teeth may be subjected to excessive stress as a result of abnormal wear. The principles of the variations in the distribution of force were cited. These principles relate to conditions in which the force is so applied that the tipping of the tooth tends to produce a pressure pericementitis. The intermittent force is applied to the tooth at such an angle that the crown is gradually moved beyond the functional range, pulling the fibers attached to the crest of the bone on the traction side, with corresponding compression of the peridental membrane on the pressure side. To inflict injury of consequence the balance between the force applied

and tissue resistance must be so disturbed that the supporting structures are lacking in vigor to respond sufficiently to the stimuli of the extra force during the rest periods available for that purpose. Again it may be stated that this lack of balance may be due either to the moment of the force, or to the condition of the supporting structures.

These changes are of very slow progress. The time, in reality, is that required for the imperceptible day by day wear, to which is added the delay which the also imperceptible day by day compensatory development of the supporting structures imposes. The latter successfully meets the stresses of the ever increasing load for a long time, but the resistance may finally break and result in actual damage.

DISEASES AFFECTING INDIVIDUAL TEETH. Diseases affecting one or several teeth may be contributing factors. In considering the influence of mastication in preventing deposits of calculus (in this volume) a case is reported of a boy of fourteen whose teeth and gums on the right side were the picture of perfect health and cleanliness, while the bicuspid and molars on the left side were very heavily coated with salivary calculus. An open cavity in a left first molar had caused him to chew exclusively on the right side for several months rather than go to a dentist. If this condition had been allowed to continue, the periodontal structures on the right side would certainly have become stronger because of excessive use, and those of the left side would have become weaker from disuse. Tests with the gnathodynamometer show that a person will not bite as hard on a tooth with an apical abscess or a considerable pericemental pocket as on other teeth. However, such persons may state that these teeth give no discomfort in mastication. The fact is that they subconsciously do their hard chewing on the other side.

Persons who for any reason form the habit of masticating mostly on one side of the mouth will eventually develop a malocclusion as a result of the excessive wear of those teeth. This applies to a large number of persons.

MAJOR AND MINOR MALOCCLUSION. Those mouths in which there are outstanding conditions of malocclusion are listed under the several orthodontic classifications and need not be considered here. There are many minor variations in which at least a few teeth are out of position. In others, teeth have shifted more or less as a result of extractions and proximal wear. It is evident that many mouths present abnormalities which might be conducive to the development of excessive stresses.

DENTAL OPERATIONS. The many dental operations which in one way or another have a part in disturbing the balance between the forces and stresses must be included. These consist of restorations of all types, which cause either direct interference with the normal excursions of certain teeth or, by falling short of the normal occlusal relations, reduce the stresses upon other teeth. A

fixed bridge that is otherwise perfect, may eventually bring about the destruction of the denture because the gold used to cast the occlusal surface was too hard; it will wear more slowly than the natural teeth. A removable bridge or partial denture may lead to disaster by its failure to maintain the teeth in the proper occluding plane, as a result of resorption of the tissues on which it rests.

ABRASION. Another factor which may be of importance is that condition which permits or is conducive to abrasion. This subject is briefly discussed in Volume I, page 316. Figure 131 in that volume shows the extensively abraided temporary teeth of a child five and a half years old, and a case is reported in which all of the temporary teeth were worn practically to the level of the gums. This occurs also in adults of almost any age. Cases of extensive abrasion cannot be accounted for on the basis of use alone. Some unknown factor appears to cause degenerative changes which are responsible for the rapid wear. As has been mentioned, in cases of rapid and extensive abrasion, there may be no injury to the supporting structures. The wear is abnormally rapid in relation to the use of the teeth and the supporting structures successfully withstand the lateral pressures, which become less as the cusps are worn away and the occlusal surfaces become flat.

CHANGES IN THE PERICEMENTAL STRUCTURES.

The studies of Oppenheim and Stuteville have demonstrated very clearly the changes which occur in the pericemental structures as a result of the tipping movement of a tooth with appliances. In many cases of excessive occlusal stress, there is, in general terms, the same tipping movement of the tooth within its socket, as described by Maxwell. The effects upon the various tissues are closely similar, although the age of the patient and the time factor in the application of the two forces are not comparable. In pressure pericementitis, the changes in the tissues would be expected to require much more time.

TIPPING FORCE LABIALLY ON UPPER ANTERIOR TEETH. Illustrations of three upper anterior teeth are presented in Figures 1433, 1434 and 1435. These are very unusual in that the three teeth were in the mouth of the same man, 45 years of age, and they show three different stages of injury to the peridental structures, as a result of excessive occlusal stress. The bite was such that all three teeth were being gradually tipped labially. Figure 1433 illustrates a very early stage. On the labial side, which is under pressure, the crest of the alveolar bone appears to be intact, although there are several very slight resorption regions on the peridental membrane side of this process, which are shown by microscopic examination. New bone has been built on the gum side of this process to reenforce it against complete resorption. There is active resorption in the pressure region on the lingual side of the apex of the root. The condition of traction is very clearly shown on the labial side of the root toward the apex, and on the lingual side

at the position of the crest of the process. In both positions it will be noted that new bone has been laid down on the peridental membrane side of the process, in response to the pull on the fibers. The inflammation of the labial gingiva is probably due to the deposit of calculus.

Figure 1434 shows considerable progress in the destruction of the alveolar bone on the labial side. Active resorption is in progress on the peridental membrane side of this bone for about one-



FIG. 1433.



FIG. 1434.

FIG. 1433. Pressure pericementitis. An upper anterior tooth, the crown of which was tipped slightly to the labial. The pressure and traction regions are shown. See text.

FIG. 1434. Pressure pericementitis. An upper anterior tooth, the crown of which was tipped considerably to the labial, causing changes in the bone. See text.

half the distance from the crest toward the apex, while new bone has been built on the gum side. Also in the other pressure region, on the lingual side of the root near the apex, much bone has been resorbed. In the traction regions, on the labial side of the root near the apex and the lingual side near the crest, there is much less evidence of stretching than in Figure 1433 and there has also been less building of new bone. It appears that this tooth had considerable labio-lingual motion, as is evidenced by the resorption of bone

on both sides near the crest and also about the apex of the root. The center of rotation was about half way between, where the peridental membrane is narrow on both sides of the root. There is rather extensive inflammation of the peridental membrane on the labial side for some distance from the gingiva.

Figure 1435 shows the almost complete destruction of the labial alveolar process, yet the attachment of the peridental membrane to the cementum is maintained for the greater part of the distance corresponding to the loss of the bone. This is one of the



FIG. 1435. Pressure pericementitis. Resorption of bone on the labial side due to continued tipping pressure on the crown. See text.

prominent clinical features of these cases. Bone resorption occurs in advance of the detachment of the peridental membrane. The gingival half of the gum tissue on the labial side shows a marked round celled infiltration, while there is no inflammatory reaction in the apical half of this tissue. The oblique fibers of the peridental membrane are discernable toward the apex. There is active resorption in the pressure region on the lingual side near the apex. The traction regions show slight signs of stretching of the peridental membrane and there is very little formation of new bone anywhere about the socket.

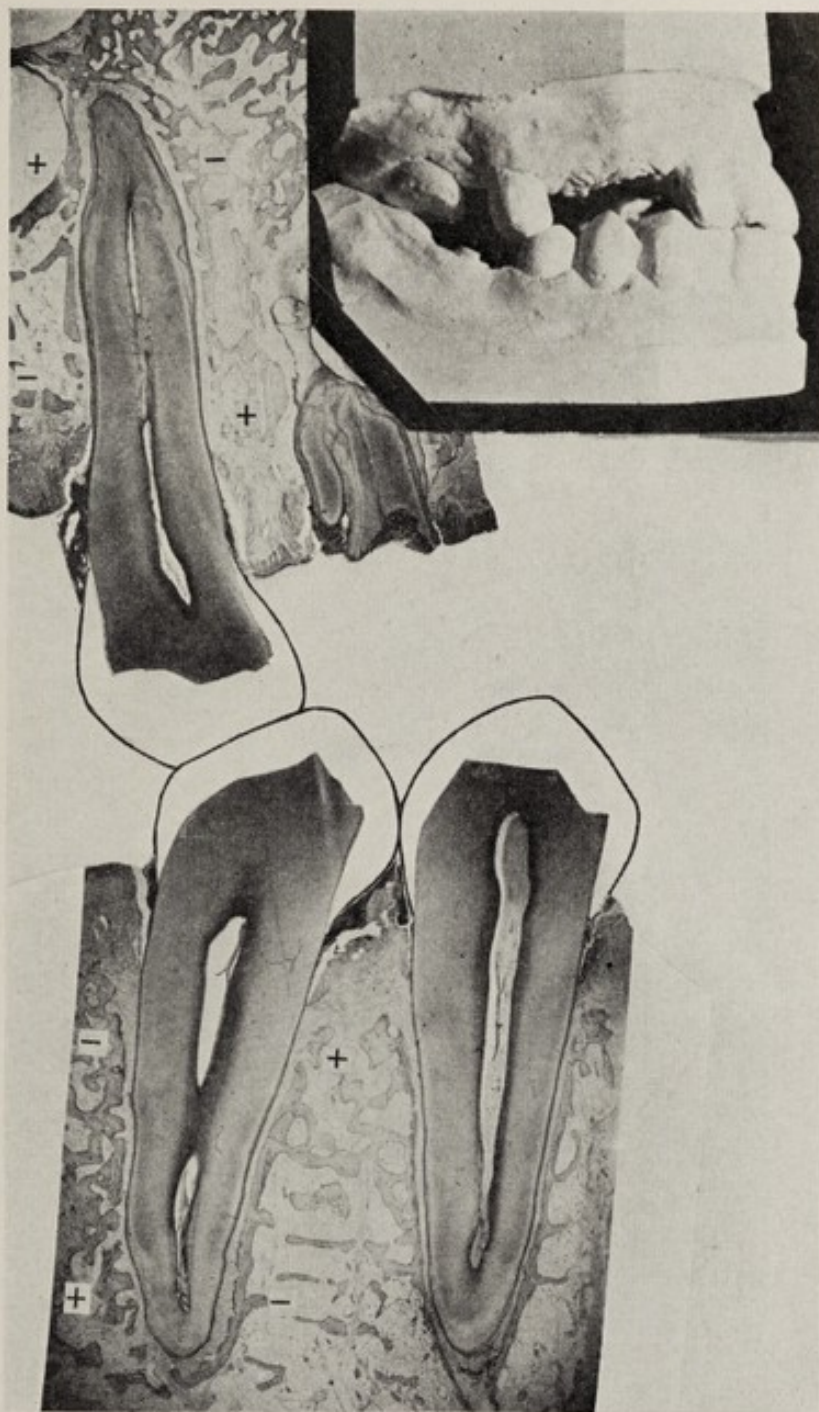


FIG. 1437.

FIG. 1436.

FIGS. 1436 and 1437. Pressure pericementitis. Plaster models and photomicrographs show occlusal relations of second bicuspid, upper and lower, which tended to tip both crowns mesially. The pressure regions are marked plus, the traction regions minus. See text.

TIPPING FORCE IN MESIO-DISTAL PLANE ON BICUSPIDS AND MOLARS. The Figures 1436, 1437, 1438 and 1439 are presented to illustrate the effect of excessive occlusal stress applied in the mesio-distal plane of the teeth. Figure 1436 is a plaster model of the upper and lower jaws*, with the upper and lower teeth in their occlusal relations. It will be noted that the upper and lower sec-

* Supplied by E. Mueller.

ond bicuspid are the only teeth posterior to the lateral incisors that were in function on the right side of the mouth. Separate photomicrographs of mesio-distal sections of these teeth, also the lower first bicuspid, are shown with slight magnification in Figure 1437, with the teeth in approximately the same relation that existed in the mouth. The outline of the enamel of the crowns has been added to reproduce the approximate occlusal relations, in order that the changes in the supporting structures may be more readily understood.



FIG. 1438. Higher magnification of the lower second bicuspid shown in Figure 1437.

In Figure 1437 the pressure regions on both teeth are indicated by plus signs, the traction regions by minus signs. The effect of the force of the occlusion is to tip both teeth mesially. Figure 1438 is a mesio-distal section through the lower second bicuspid; the mesial side is to the right. The regions of traction toward the crest of the alveolar process on the distal side and near the apex on the mesial side are very beautifully shown. The darker regions along the inner surface of the bone in both positions indicate the new bone laid down as a result of the traction on the fibers of the

peridental membrane. The regions of pressure are toward the crest on the mesial side and near the apex on the distal side. In both cases, slight resorptions of bone are in progress. It will also be noted that the crest of the bone on the mesial side is much reduced as compared with that adjacent to the distal surface of the first bicuspid, which was non-functional.

Figure 1439 is a similar section of the upper second bicuspid, the mesial side of which is to the right. In this the traction region on the distal side near the crest shows a very little new bone, while



FIG. 1439. Higher magnification of the upper second bicuspid shown in Fig. 1437.

in the traction region on the mesial side near the apex, considerable new bone has been built in layers. In the pressure region on the mesial side near the crest, resorption of the bone has occurred. There has also occurred considerable resorption of bone on the distal side of the root toward the apex.

OSTEOSCLEROSIS. Figures 1440 and 1441 are reproductions of radiographs illustrating osteosclerosis, nature's apparent compensatory reaction to excessive stress. The lower second molar, Fig-

ure 1440, had tipped mesially in erupting in the endeavor to take the position of the first molar, which had been extracted. The force of the bite was, therefore, exerted in a direction to press the full length of the mesial side of the mesial root against the bone almost at right angles to the body of the mandible. Instead of being resorbed, the bone has become more dense in order to resist the stress. In Figure 1441 sclerosis has occurred, apparently as the result of pressure in the direction of the long axis of the root. There had been considerable resorption of the crest of the bone about the mesial root, with more recent infection of the peridental membrane.

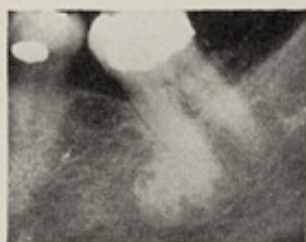


FIG. 1440.



FIG. 1441.

FIGS. 1440 and 1441. Two cases of osteosclerosis.

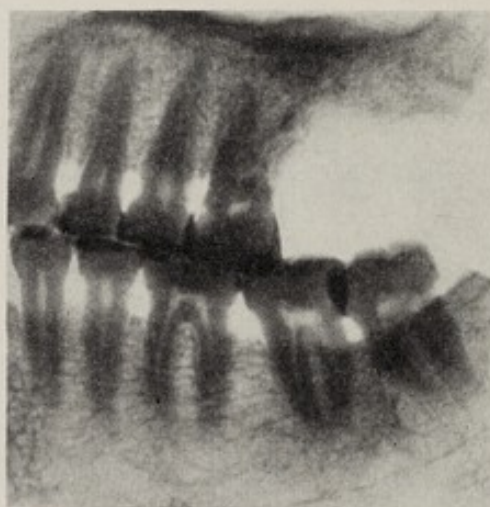


FIG. 1442. Osteosclerosis about lower first molar.

Figure 1442 illustrates nature's reaction to heavy stress in a case in which the radiograph shows the upper and lower teeth in occlusion, so that the direction of force, as applied to certain teeth, may be observed. This person was fifty years of age. The worn occlusal and proximal surfaces attest to the vigorous use of the teeth in mastication. The crests of the bone of the alveolar process and the gingivæ had receded, but there were no pockets; the peridental membranes were in excellent condition. The bone about the roots of the bicuspid is of good structure as a result of the active use of these teeth, which were in normal occlusion.

Particular attention is called to the fact that the distal half of the occlusal surface of the upper first molar makes contact with the mesial half of the occlusal surface of the lower second molar and, since the upper second molar is missing, this tends to tip the lower second molar mesially. However, in the case of this normally healthy individual, the close proximal contact of the lower first and second molars retarded the mesial movement of the crown. Nature's reaction to this force is expressed by an increased density of the bone in the apical region on the distal sides of both roots of the lower molar. In healthy individuals, an increase in the force of the bite tends to strengthen, rather than weaken, the supporting structure. The bone about the third molar, which is functionless, is definitely cancellous, because there is no functional need for dense bone. The reaction of the bone about these teeth illustrates nature's adjustment of the supporting structures to the use of the teeth in mastication — strong, dense bone when required; cancellous bone when that will answer the purpose.

SUMMARY OF TISSUE CHANGES. The tissue changes which occur in pressure pericementitis are directly related to the magnitude of the occlusal stress and its direction on the one hand and the resistance of the supporting structures on the other.

In cases in which the force is applied in the direction of the long axis of the tooth, the response of the supporting structures is partly expressed in increased density of the bone and a general strengthening of the periodontal membrane, cementum and bone. In practically all cases of this type in which the stress is increased gradually, the compensatory reaction is likely to be ample, therefore no harm results. In an occasional case in which excessive force is applied, as by the placing of a restoration, the occlusal surface of which is "too high," there may occur resorption of the bone about the apex of the root, which might be mistaken for a chronic abscess. This is likely to cause no permanent injury if the occlusion is promptly relieved, as the damage is confined to the bone. The situation is analogous to that on the labial side of the root in Figure 1435, except that the tendency to rebuild bone in the apical region is much greater than along the sides of the root, particularly near the crest.

In cases in which the excessive stress is the result of the protrusive and lateral excursions of the mandible, the force is in the main exerted more or less in the labial, buccal or lingual direction, and the damage occurs as a result of tooth movements caused by these forces. In cases of extensive abrasion, the resistance of the supporting structures is often successful in preventing undue movement of the teeth, so that they continue to wear without harm to the supporting structures.

Attention is again called to the fact that the stress may be no greater in magnitude upon the tooth which is damaged than on corresponding teeth of the same arch which suffer no damage. In addition to the amount or volume of the force, there are two main

factors to be considered: (1) the relation of the long axis of the tooth to the direction of the force, viz: the angle of application of the force; (2) lowered resistance of the supporting tissues of the particular tooth, which fails to withstand the stress. One or both of these factors may be responsible for the movement of the tooth.

The first change of consequence results from the tipping movement of the tooth, which compresses the peridental membrane against the bone near the crest of the alveolar process. Let it be presumed that this occurs on the labial side of the root. Resorption occurs on the peridental membrane side of the alveolar process while new bone is likely to be built on the gum side. The same force moves the apex of the root in the opposite direction and may cause resorption of the bone on the lingual side of the root. At the same time the traction on the lingual side of the root near the crest of the process and on the labial side near the apex, straightens the fibers of the peridental membrane, and new bone is added to the peridental membrane side of the process to reduce the width of the space.

Resorptions of the cementum certainly do not always occur in cases where there is bone resorption due to excessive occlusal stress. Many sections show no involvement of the cementum in any position. However, many regions of cementum resorption are observed in the roots of teeth which have been subject to excessive occlusal stress, also in teeth having no definite history of such stresses. The fact is, that regardless of the cause, the large majority of cementum resorptions are promptly healed by the building of secondary cementum and apparently do little if any harm.

When a little of the bone of the crest of the process has been destroyed, space is made for a slight additional movement of the tooth when force is applied. The angle of the axis of the root in relation to the bone is increased and the lowered crest is more readily resorbed. The movement of the tooth is intermittent; it is pushed laterally each time the stress of occlusion is brought upon it and the fibers on the opposite side, which were stretched by the movement, in resuming their spiral or wavy form, pull it back to, or nearly to, its previous position. After a time the tooth has sufficient movement to weaken its mesial and distal contacts with its neighbors and the peridental tissues become inflamed as a result of the impaction of food, or from the often repeated movements as a result of cusp interference. Eventually, infection may occur and destroy the peridental membrane.

PHYSIOLOGICAL MOVEMENTS OF THE TEETH

Since the physiological movements of the teeth are directly related to conditions which cause pressure pericementitis, brief consideration will be given to these movements, also to certain other movements which appear to occur as a result of interference with or interruption of the normal physiological trends.

The use of the teeth in mastication results in *normal* wear of both the occlusal surfaces (also incisal edges) and the proximal surfaces of all of the teeth. This wear should be differentiated from that to which the term *abrasion* has been applied. Abrasion is an abnormal wear, which also involves both the occlusal and proximal surfaces. Abrasion is discussed in Volume I, page 316.

The normal wear of the occlusal surfaces occurs very gradually as a result of the frictional contact of these surfaces in mastication. The wear of the proximal surfaces occurs at the position of the contact points as a result of the slight bucco-lingual or labio-lingual movements of the teeth in mastication. The wear of both the occlusal and proximal surfaces of the molars, bicuspid and cuspid is more pronounced than that of the incisor teeth. The proximal wear may be so slight that it is not noticeable as one examines the teeth of a person of middle age, yet it may be seen in practically all cases when extracted teeth are examined. When one considers that there are thirty proximal surfaces in each arch, the combined wear may be considerable.

In the continuously growing anterior teeth of rodents there is a correlation between growth and wear. The wear of use is compensated by the growth and the teeth are of practically the same length continuously.

Nature's compensatory adjustment for the wear of the human teeth lies within the supporting structures and consists of the occlusal movement of the tooth to compensate for normal wear, also the mesial movement of all of the teeth to balance the wear of the proximal surfaces and to maintain tight contacts. There appears to be the phenomenon of continuously exerted force to maintain both the occlusion and the proximal contacts.

DRIFTING OF THE TEETH. This term and the term *wandering of the teeth* have been applied to the above described physiological movements, which are always active to maintain the most effective use of the teeth. It seems more appropriate to confine the term *drifting*, which may be defined as *aimless wandering*, to those cases in which the physiological movement goes astray, in some cases because of the loss of teeth, in others possibly because of a disturbed metabolism.

When a tooth has lost its occlusion, because of the loss of one or more teeth in the opposite arch, it will usually become "elongated" or will move farther and farther occlusally by the continued, but unopposed, physiological force, exposing more and more of the cementum as it is extruded. The movement may continue until the occlusal surface is in contact with the gum of the opposite arch. In such a movement, the contacts with the proximating teeth may be either weakened or abnormally broad. In some cases, particularly when several teeth of the opposite arch are missing, all of the supporting structures will accompany the teeth in the movement, so that a section of the jaw is "elongated" with the teeth.

When a tooth is extracted in either arch, as, for example, a first molar, the second molar will tend to move mesially in an apparent effort to close the space. Another and even stronger force is often concerned in this movement, as is evidenced by the tendency in such a case, of the second bicuspid to move distally, in opposition to the normal mesial trend; similarly the second molar may move distally and open the contact between itself and the first molar, following the extraction of the third molar. In the healing of the first molar socket in the case just mentioned, there seems to be exerted a pull upon the transeptal and other proximal surface fibers of the peridental membranes of both the second bicuspid and second molar, to draw them toward the vacant space. The term *drift* may be appropriately applied to these movements, because the normal relations of the teeth have been upset by the loss of the first molar.

This term may also be applied to those teeth which wander labially, buccally or lingually from their normal positions in the arch as a result of some disturbance in the balance of forces, without the loss of attachment of the peridental membrane, but presumably due to changes within the supporting structures. Similar movements occur in cases in which teeth are occlusally functionless, but have no discoverable disease or injury to the peridental tissues.

DIAGNOSIS.

The special diagnostic methods for pressure pericementitis should be a part of the routine examination for all adults. The diagnostic signs are: undue motion of the tooth, which is always present. Wear of an occlusal surface may appear as a facet on the enamel or as an indication of cusp interference on a restoration. Gingivitis is likely to be present only when the condition has made some progress; not until the tooth has sufficient motion to cause irritation. Deposits of serumal calculus on the enamel of the gingival crevice, which are a result of the gingivitis. Tenderness to pressure and occasionally actual pain may be present in the later stages, usually as the result of an injury, as by biting on some hard substance. The essential condition is a tooth that has undue motion without detachment of the peridental membrane.

The dentist must rely on his own initiative for the early discovery of cases of this type. Usually but one or two teeth are involved at first, and there are no symptoms observable by the patient. The slight looseness of the tooth may not be noticeable to the eye, but can be felt with the finger applied to the labial or buccal surface of the tooth while the patient makes lateral or protrusive movements of the mandible with the teeth in pressure contact. The finger should be held against the surfaces of two or three teeth in order to detect the slightest comparative movement.

Signs of disuse atrophy relate to individual teeth, or groups of teeth in almost any position. A clearly functionless tooth, one which has no opponent in the opposite arch, is an outstanding example, although it is not a result of excessive occlusal stress

elsewhere in the denture. Such a tooth will generally show signs of lack of natural cleaning — the occlusal surface lacks gloss and the gingiva may be slightly inflamed; it may or may not be loose, but it will usually become elongated. It is important to discover those teeth which are in their proper positions, but which make less than normal pressure contact with their opponents. Such teeth should be advanced into proper function by normal physiological movement, but a slight abnormality of form or position may prevent this. Conditions resulting from malpositions of teeth, from drifting subsequent to extractions, and from improper restorations, constitute the bulk of cases of teeth in complete or partial disuse which require attention.

PROCEDURE IN EXAMINATIONS. Each and every tooth in the mouth should be tested by grasping it between the thumb and first finger to determine whether undue motion may be detected in this way. It may be more convenient to use both first fingers for some second and third molars. The occlusal surfaces should be examined for wear, which is most likely to occur first in the cuspid region, also for signs of undue stress on teeth with restorations which are "too high." Abrasion is not always a sign of pericementitis, because the resistance of the supporting tissues may be sufficient to prevent movement of the teeth. Those teeth which show wear but were not recognized as having undue motion by the test mentioned above, should be tested with the first finger applied to the labial or buccal surface while lateral and protrusive movements are made with the teeth in pressure contact. The contacts should be tested and the gingivæ examined for inflammation. Deposits of serumal calculus should be looked for by retracting the gingivæ, or with a sharp pull scaler. Peridental membrane explorers should be used to determine whether detachments of the membrane have occurred about any of the teeth which were discovered to have undue motion. If detachments have occurred and there is infection, the diagnosis for the particular region is chronic suppurative pericementitis.

In more advanced stages, the diagnosis of pressure pericementitis presents no difficulty. As cases progress, the teeth have more and more motion, which is usually in the bucco-lingual direction or the reverse, the occlusal wear is more extensive, the gingivæ are more likely to be inflamed and the patient may complain of tenderness. The extent of the occlusal wear is a less important diagnostic sign than the movement of the tooth. In cases in which there is a mesial or distal movement, the first definite sign may be a weak contact.

The examination should include an inquiry into the local factors which might have inclined the patient to form an undesirable habit of mandibular movement which would account for the abnormal wear.

The condition of the health and vigor of the supporting structures is usually more difficult to determine. If the damage to

these tissues seems to be out of proportion to the trauma, inquiry should be made along the lines suggested in stating the causes. The dentist may make inquiry into the occupation and as to medical treatment that may be in progress, either of which may suggest a reason for lowered resistance; a blood examination may also be made. He may ask the patient's physician to examine the patient and make a report.

Radiographs may afford considerable information. The structure of the bone should be examined for regions of sclerosis and resorption of bone, in relation to the positions and occlusion of the teeth.

Plaster study models should be made of all cases in which more than one or two teeth are involved and particularly when there are apparent irregularities of position of teeth, or if several teeth are missing. The models should be very perfect and should show the positions of each cusp in relation to the surfaces with which it may occlude.

Treatment of Pressure Pericementitis

PREVENTION.

Injuries of this type are nearly always preventable. As with most other conditions the successful application of prevention depends upon an early diagnosis. This consists in close watchfulness by making critical examinations of the dentures of all adult patients as a routine procedure. Especial attention should be given to dental operations which exhibit signs of cusp interference, also evidence of abnormal use of the teeth in mastication and the conditions which might induce it.

TREATMENT.

The treatment of pressure pericementitis depends upon the conditions presenting. In cases in which a single tooth shows the effects of undue pressure, it should usually be treated by slight grinding of an inclined plane of a cusp of the tooth involved or its opponent, so that no motion can be detected during the lateral or protrusive movement of the mandible with pressure contact. This should be followed by the study and treatment of all conditions which might contribute to the abnormal wear either directly or through abnormal habits in mandibular movements.

In the desire to limit the recommendations for treatment as closely as possible to procedures in the field of operative dentistry, no consideration will be given to that very large group of cases in which rather elaborate reconstruction with crowns, bridgework and partial dentures may be necessary.

REESTABLISH A JUST AND EQUITABLE DISTRIBUTION OF FORCE. Grinding of occlusal surfaces should be undertaken with great caution, because it may lead to the establishment of additional regions of excessive stress. The effort should be made to reestab-

lish a just and equitable distribution of force, which must oftentimes include the limitation or modification of mandibular movements. Certain cusps may be built up to limit lateral or protrusive movements, as described in the treatment of abrasion in Volume III, p. 273. The habitual movements of the mandible may be changed by making it more comfortable for the patient to do heavy chewing on the opposite side from that to which he has become accustomed. In many cases one side of the arch has been in partial disuse, and it will be necessary to correct the conditions on that side, in order that it may be used effectively and comfortably. It may be necessary to induce the patient to put himself through a course of training to develop stronger supporting structures on the weak side. The importance of this must be stressed if cooperation is to be expected.

A case is recalled in which assistance of the daughter of a man of forty-five was obtained. This patient had used the teeth of the left side almost exclusively for a number of years on account of an open contact on the right side. After this contact was restored he continued to use the left side because he could bite with greater force on that side without discomfort. For several months the daughter kept a little "place-card" standing near his plate at the table which carried the inscription in bold letters "Keep to the Right." Thus reminded, he gradually increased his use of the right side.

CORRECTION OF MALPOSITIONS OF TEETH. Many major irregularities of occlusion are not corrected during childhood, and these may lead to disaster in later life. There are, however, many minor irregularities, which contribute to uneven wear and a considerable number of these may be corrected by the use of orthodontic appliances. Reference is made particularly to single teeth that are misplaced, such as upper anterior teeth which close inside the lower teeth and bicuspid which are one cusp width to the buccal or lingual. Generally it requires a little separation of the adjacent teeth and a change in the direction of the long axis of the tooth. The apex of the root is usually in approximately the proper position, but the crown was deflected from its normal path during eruption. There appears to be no reason why such conditions should not be corrected for persons up to middle age. The separation in these cases may often be conveniently obtained with a Ferrier separator, using the long adjusting bars, illustrated in Volume II, Figure 504.

There is a case in the author's records of a patient in whose mouth the upper right temporary cuspid had been retained between the permanent cuspid and lateral incisor. The occlusion was normal in the bicuspid and molar regions on both sides, but the upper incisors were unduly prominent. Resorption of the root resulted in the loss of the temporary cuspid when the patient was thirty-seven years of age. It was decided to correct the deformity by retracting the four incisors to bring the right lateral into its

proper position in contact with the cuspid. Seven months were required to move the teeth to their normal position and the stay appliance was in place for two years. This patient was under observation for about five years after the stay appliance was removed, and the contacts from cuspid to cuspid remained tight.

WHEN TEETH ARE VERY LOOSE. When teeth have become considerably loosened it may not be sufficient to relieve the excessive stress. Under similar circumstances, the orthodontist uses an appliance to stabilize the teeth, with the expectation that the bone which has been resorbed will be rebuilt. In both cases the tooth is loose without detachment of the fibers of the peridental membrane, and there is no infection. When the teeth are stabilized in the child's mouth, the bone is usually rebuilt. It is logical to expect the same reaction of the tissues in the adult, although more time will be required. The success of the effort will depend, to a considerable extent, upon the elapsed time since the bone was resorbed. In Figure 1436 the supporting structures on the labial side of the root may be divided into three zones: (1) near the apex of the root, both the oblique fibers and the bone to which they are attached may be seen; (2) for a considerable space incisally of the first zone, the oblique fibers are clearly visible as they pass from the cementum out into the connective tissue, where there are only a few slight specks of bone; (3) farther to the incisal, the attachment to the cementum is maintained, but no oblique fibers are visible; presumably they have atrophied from disuse. The probability of bone rebuilding under the conditions existing in the second zone seems to be much greater than in the third zone. The stay appliance should be kept on for at least a year in any case, and often for two or three years, depending upon the conditions.

Chronic Suppurative Pericementitis

BIBLIOGRAPHY ON INVESTING TISSUES PAGE 265

ILLUSTRATIONS: FIGURES 1456-1507.

CHRONIC suppurative pericementitis is the term applied to a chronic infection of the supporting structures of the teeth, which results in the gradual destruction of the peridental membrane and the adjacent bone of the alveolar process, leaving a pocket between the root and the gum tissue. This type of infection is always an extension of a preceding gingivitis, or a pressure pericementitis which involves the tissues in the region of the crest of the bone of the alveolar process. This is a slowly progressive non-specific inflammatory process, in which pyogenic organisms are generally present. The term *chronic pericementitis* will generally be used to designate this condition.

There seems to be too much of mystery regarding the pathology of this disease and too much of magic in its treatment. This has been true throughout the centuries as far back as the records may be followed. The planting of teeth as a method of treatment has been revived again and again since the latter part of the sixteenth century. The attention which this operation attracted, when it was recommended by Sir John Hunter in 1778, is reflected in the cartoon by Rowlandson, a famous English artist, published in 1787. This is reproduced in Figure 1456.

The mystery as to the pathology was justified until comparatively recent years, as the first histological studies of these tissues were published only fifty years ago, in 1886 and 1887. The first illustration of the tissue forming a pocket, published by Atkinson in 1888, is reproduced in Figure 1282, and another by Talbot in 1896 in Figure 1283. It is not surprising, therefore, that the pathology of this condition has not been understood, particularly because the relationships of the tissues involved are unusual and are not duplicated elsewhere in the body. Until comparatively recent years, most of the writings on treatment were based entirely upon clinical observations, by dentists unfamiliar with the meager histo-pathological studies that were available.

In medicine, so long as the pathology of a disease has been veiled in mystery, there has been more or less of magic employed in the treatment. The diseases of the investing tissues of the teeth have occupied this position in dentistry for so many years that the change to more rational methods of treatment has been very slow.

The histo-pathology of the supporting structures of the teeth, as well as their functions and reactions are sufficiently understood that rational treatment may, in most cases, be planned and carried out with assurance as to the prognosis. The methods presented

in this volume were gradually developed during the past twenty-five years and have been followed in the daily routine of many general practitioners for the past fifteen years or more.

The diagnosis and classification of cases is simple and the effort has been made to so systematize the treatment, based on tissue reactions, that it may be applied effectively. To do this, the care of the investing tissues must be incorporated into the dentist's daily routine of service, in the same manner as that of dental caries.



FIG. 1456. A famous dental cartoon, by Rowlandson, published in 1787, depicting the operation of transplanting teeth from the mouths of the poor to those of the wealthy.

FREQUENCY. In a report* of an examination of 6,000 radiograms of the mouths of 600 adults, without previous inquiry as to the condition of their general health or of their teeth, the effort being to learn average conditions, the following tabulation appears:

Age	Number of persons	Number having bone destroyed at sides of roots	Percentage having bone destroyed	Average number of areas per person for entire number in group
20 to 24	146	18	13	0.6
25 to 29	119	34	29	2.0
30 to 39	146	101	68	5.7
40 to 49	111	87	77	7.1
50 and over	78	69	88	9.0
	600	319	53	5.0

This gives 53 per cent of persons over twenty years of age with one or more regions of bone destroyed about the sides of the

* Journal American Medical Association, October 19, 1918, Vol. 71, p. 1279.

roots of the teeth by a chronic suppurative process. The rapid percentage of increase beyond thirty years of age in the number of persons, also the increase in the average number of pockets per person with advancing years, both point to the serious relationship of this type of chronic infection to general health at the period in life when the resistance is likely to be temporarily or constantly lower than in young adult life.

CAUSES OF CHRONIC PERICEMENTITIS.

GINGIVITIS ALWAYS PRECEDES. Some form of gingivitis always precedes the formation of a pocket. Deposits of serumal calculus in the gingival crevice, or the various forms of injuries to the gingivæ which have been mentioned, are the most frequent fore-runners. A considerable number of cases result from variations in occlusal stresses, which cause inflammation of the supporting structures in the region of the cemental line and practically always include the gingivæ.

SERUMAL CALCULUS ON THE ENAMEL. Deposits of serumal calculus on the enamel within the gingival crevice cause many pockets on buccal, labial and lingual surfaces. As has been explained, the presence of these deposits maintains a low grade chronic inflammation of the gingivæ which eventually extends to the pericemental tissues.

SALIVARY CALCULUS SHOULD NOT BE CONSIDERED A CAUSE. Deposits of salivary calculus usually destroy all of the tissue adjacent to the root to a depth even with the deposit, and pockets alongside the root are not formed, as a rule, except in the later stages. While superficial suppuration of the tissue which is covered over by the deposit is commonly present, it is only in a limited number of cases that the peridental membrane is stripped away from the cementum in advance of the destruction of the adjacent tissue. Deposits of salivary calculus should not, therefore, be considered as a cause of suppurative pericementitis in other than exceptional cases.

INJURIES TO THE GINGIVÆ. By far the largest number of cases occur as a result of injuries to the gingivæ, and of these, the injuries to the septal tissue as a result of the impaction of food between the teeth in any of the many conditions cited, are both the most frequent and the most serious. In many cases, the irritation caused by the presence of the impacted food, which is often invaded by saprophytic organisms, plays a part in establishing and maintaining the inflammation. In some cases the impaction may of itself result in the beginning detachment of the peridental membrane at the cemental line. More frequently a suppuration occurring in the inflamed gingivæ is carried into the deeper tissues by the lymphatic vessels.

PRESSURE PERICEMENTITIS. This form of pericementitis paves the way for many cases of chronic infection of the peridental membrane. It is due to uneven occlusal wear of the teeth and other conditions which result in excessive stress on one or more teeth every time the jaws are closed in certain lateral or protrusive movements. This force tends to tip the tooth slightly in its socket and causes certain pressure and traction regions, previously described; it may also cause pressure resorption of the crest of the alveolar process on the pressure side. The peridental membrane in the region of pressure remains attached to the cementum until, as a result of irritation caused by the movements of the tooth, it becomes involved in a low grade infection. The infection is superimposed and usually gains entrance through the epithelium of the gingival crevice. It occurs occasionally on the traction side near the crest, particularly to the lingual of the upper incisors, when their crowns are moved labially. Severe pressures and infections of the interproximal tissues occur most frequently between the bicuspid and molars.

SYSTEMIC CONDITIONS. It must be recognized that the general physical condition of an individual will have its effect upon both the beginnings and progress of chronic pericementitis, yet there is little evidence that disease of the peridental membrane originates from systemic conditions. It seems more likely that the vital resistance of the tissues, as a reflection of any one of many systemic conditions, may be conducive to the occurrence of every type of gingival and pericemental inflammation. As has been mentioned, the metallic poisons, diseases of the blood-forming organs and any of a number of systemic diseases, may cause sufficient irritation of the gingivæ to appreciably lower their resistance, and infection may occur without the intervention of a definite local irritation. On the basis of present knowledge, it would seem that the organisms concerned in the destructive detachment of the membrane are factors by which the tissue becomes involved secondarily to some form of irritation.

LOCATION OF POCKETS. Pockets occur most frequently in the bicuspid and molar region — the region of the mouth in which the heaviest work of mastication occurs. The majority of pockets in this region result from injury to the septal tissues by the impaction of food between the teeth. In a similar way, a more limited number of cases occur in the incisor region. Cases which occur as a result of the deposit of serumal calculus on the enamel in the gingival crevice, or any of the injuries to the gingivæ which have been mentioned, may be observed about teeth in any position in the mouth. Deposits of serumal calculus in the gingival crevice occur most frequently about the anterior teeth and the third molars. Pockets which result from pressure pericementitis are more common on buccal and labial surfaces of bicuspid and incisors; although they occur on the buccal surface of molars and occasionally on the lingual surface of any of the teeth. They are particularly

likely to occur to the lingual of the upper incisors in cases in which these teeth have been moved so far labially as to seriously damage the lingual attachment.

PROGRESSIVE INVOLVEMENT OF THE SEVERAL TISSUES.

The tissue changes in chronic pericementitis are those of the preceding gingivitis, plus those which come with the gradual involvement and destruction of the deeper tissues, and the formation of a pocket between the soft tissues and the root. This condition is very unique in character. No other condition like it occurs elsewhere in the human body, because there is no other such relation of tissues as exists between the alveolar bone, periodontal membrane and cementum. The cementum is the tissue of first importance in maintaining the chronicity of the pocket. If periosteum is



FIG. 1457. Section of gum tissue cut away to eliminate a pocket.

stripped from bone, a portion of the bone dies, and is separated and exfoliated by the reaction within the adjacent bone; when the cells which build the cementum are stripped from it, it also becomes a dead tissue, but it can not be exfoliated, because a similar reaction can not occur in the cementum, due to the fact that cementum has no circulation of blood. The dead cementum therefore remains as a constant irritant to the adjacent soft tissue. In cases of a somewhat similar nature, such as the planted tooth, the reattachment of the soft tissues to the cementum occurs, but this attachment has been shown to be physiologically unstable, as manifested by the progressive resorption of the planted root and the eventual loss of the tooth. This is discussed in a brief report on the nature of the attachment of the tissues to planted teeth and the possibilities of reattachment of pocket tissues.

The principal tissue changes which occur in the progress of this disease are as follows:

GINGIVITIS, resulting from any of the conditions discussed in the preceding pages, which gives opportunity for infection. The gingivæ may show little outward sign of inflammation or they may be red and considerably swollen and may bleed on the slightest touch. In cases in which there has been impaction of food between the teeth, the septal tissue will have been compressed, and food debris may be present. There often occurs a downgrowth of the crevice epithelium into the pericemental tissues along the surface of the cementum.



FIG. 1458.



FIG. 1459.

FIGS. 1458 and 1459. Inflammations of the septal gingivæ.

LOWERED RESISTANCE OF THE GINGIVÆ. The exceptional equipment of the gingival epithelium to resist both injuries and infection, also to quickly repair breeches in its continuity, should be considered in relation to the generally low grade types of infection associated with disease of the peridental membrane. This suggests very strongly that the resistance of the gingivæ must be in some way lowered before such organisms could invade the underlying connective tissue. The lowered resistance may be the result of any of the forms of local trauma, or the systemic conditions, already discussed.

Figure 1457 shows a section of a piece of gum tissue that was cut away to eliminate a pocket. The crest of the gingiva is to the upper left. A mass of debris in the gingival crevice is indicated

by the figure 1. It will be noted that the epithelium has been almost completely destroyed in the region between 2 and 3, permitting infection to invade the deeper tissues, which are heavily infiltrated with round cells at 7. A deep projection of the epithelium is marked 4. The epithelial lining of the crevice is shown at 5, and the line between the normal and infiltrated tissue is indicated by 6.

Figure 1458 is from the mouth of an old person. It shows a rather slight inflammation of the septal gingiva due to deposits of serumal calculus on the enamel and some food debris. The edge of the cementum is shown on both teeth, and it will be noted that there has been a growth of epithelium along the surface of the



FIG. 1460. Gingivitis. At the very crest of the gingiva the connective tissue is practically without epithelial protection.

cementum on both. A very mild round celled infiltration involves the connective tissue, despite the thickening of the epithelium of the septal gingiva. Since the inflammatory reaction involves the trans-septal fibers to only a very slight extent, little bone change has occurred.

In Figure 1459 there is more inflammatory reaction than in the preceding illustration. In this case there is round celled infiltration in the septal tissue, probably as a result of several very evident breaks in the epithelial covering. Since the pocket on the left side has not progressed to the same depth as on the right side, the bone is higher on the left side.

Figure 1460 shows a markedly inflamed gingiva. At the very crest the projections of connective tissue are practically without

epithelial protection. This tissue would bleed very easily. It is apparent that microorganisms would have little difficulty in penetrating this epithelium.

The inflammation accompanying pressure pericementitis has been well illustrated in Figures 1433, 1434 and 1435.

INFECTION INVADES DEEPER TISSUES. The lymphatics within the peridental membrane form the natural route for the movement of infection. These vessels accompany the blood vessels from the gingivæ through the peridental membrane to the apex of the root, also through the Haversian canals in the bone. Figure 1461 is a section cut from the peridental membrane, which shows very clearly the first inflammatory reaction about a small blood vessel. Figure 1462 shows a more extensive round celled infiltration clus-

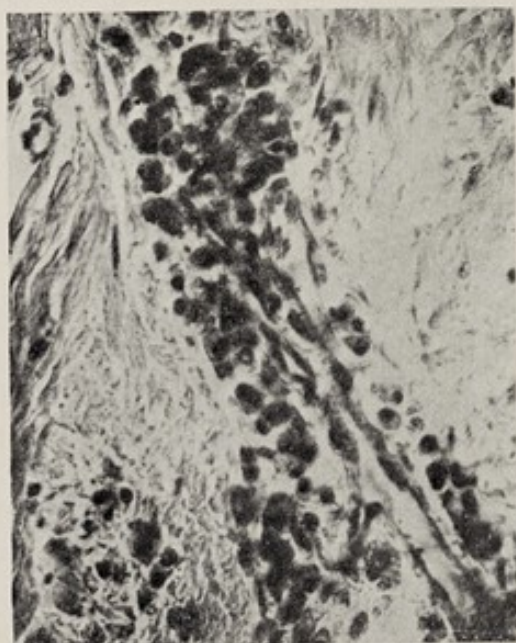


FIG. 1461.

FIG. 1461. Inflammatory reaction about a small blood vessel within the peridental membrane.

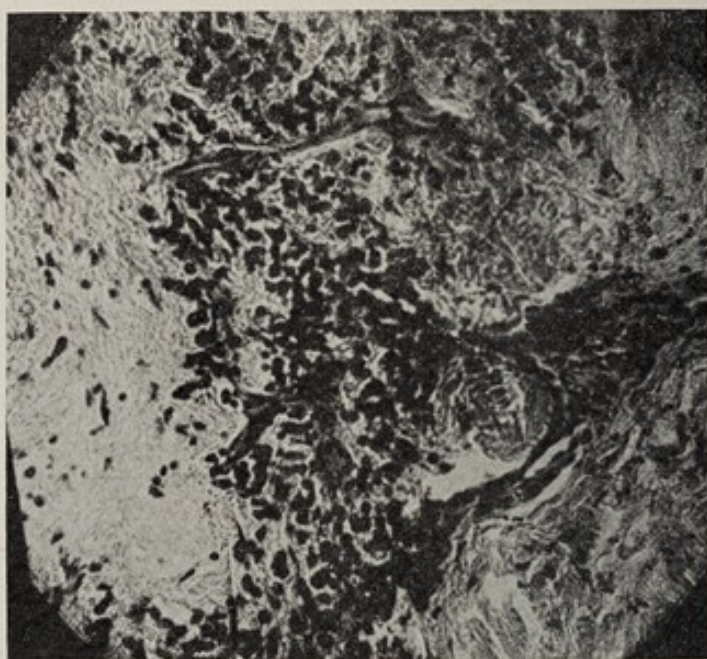


FIG. 1462.

FIG. 1462. Inflammatory reaction about several blood vessels within the peridental membrane.

tered about a number of small blood vessels in the peridental membrane. Practically all of the larger blood vessels run parallel with the long axis of the tooth and clinically it is observed that pockets progress more rapidly in depth toward the apex than laterally around the root. This is for the reason that the lymphatic vessels accompany the blood vessels and thus furnish the route by which the infection travels. Figure 1463 is a longitudinal section of normal peridental membrane in which parts of a number of blood vessels are shown, all running parallel to the long axis of the root. Figure 1265, a horizontal section, shows all of the blood vessels cut crosswise of their length.

DESTRUCTION OF THE PERIDENTAL MEMBRANE. As a result of infection of the pericemental tissues, changes occur in the peri-

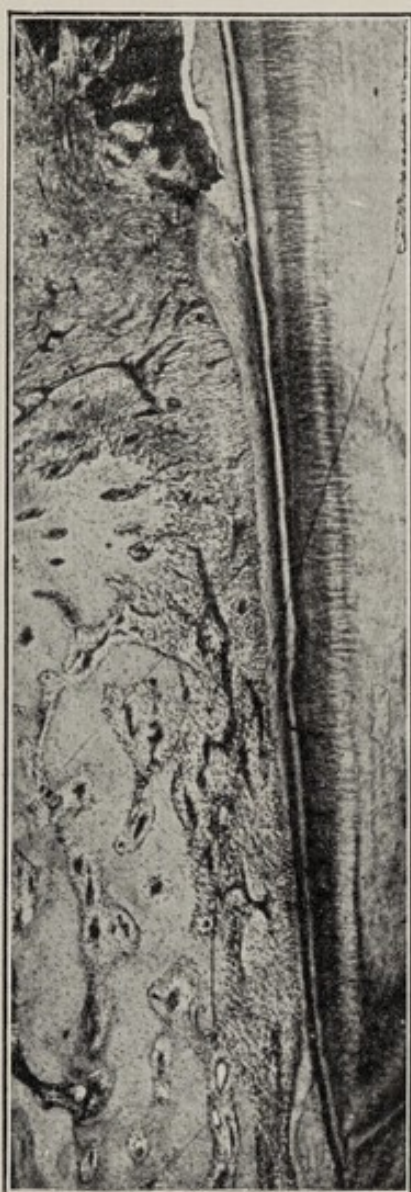


FIG. 1463.

FIG. 1463. Normal periodontal membrane. Section showing fibers attached to the cementum from the cemental line almost to the apex of the root. The fibers which pass upward into the gingivæ, those which pass to the crest of the alveolar process, and those which pass directly from the cementum to the bone are clearly shown. *Noyes.*



FIG. 1464.

FIG. 1464. Section through root and labial alveolar process of an upper central incisor, showing about one-fourth of the root close to the apex. Marked changes have taken place in both the periodontal membrane and alveolar process as a result of infection within the periodontal membrane.

dental membrane and alveolar process which are the result of a chronic type of inflammation, as is evidenced by endothelial proliferation. There is an increase in the interstitial tissue about the blood vessels; the vessel walls become thicker and the vessels may eventually become obliterated. Breaks occur in the periodontal membrane, principally along the lines of several blood vessels. As a result, a soft tissue pocket is formed with ends of severed fibers of the periodontal membrane attached to the cementum on one side and to the alveolar process on the other.

This break deprives the connective tissues of their normal epithelial protection and exposes them to the fluids of the mouth and to many types of infection. There is always a downgrowth of epithelium into the pocket, although it varies widely in the protection it affords. This will be discussed later.

Figure 1464 is a section through the root and labial alveolar process of an upper central incisor, showing about the apical fourth of the root close to the apex. This patient was forty years of age. The peridental membrane on the lingual side of this tooth was detached almost to the apex and the pocket extended around on both the mesial and distal sides of the root, but not so deep as on the lingual. This tooth was extracted by the author on May 27, 1912. With the patient under nitrous oxid anesthesia, two incisions



FIG. 1465. Longitudinal section through peridental membrane, showing round celled infiltration along the blood vessel routes as a result of a shallow pocket. The pocket does not show in the illustration.

were made through the labial gum parallel to the length of the root and a third incision was made horizontally near the position of the apex, meeting the other two. The alveolar process was cut through with a drill in the engine along the same lines, and the tooth, the labial peridental membrane, alveolar process and gum tissue, were removed together. Marked changes have taken place in the peridental membrane along the lines of the blood vessels. Many blood vessels, disposed parallel to the long axis of the tooth can be seen, also several passing through the alveolar process into the gum tissue, and there is slight round celled infiltration around all of these vessels, similar to that in Figures 1460 and 1461. There is much less than the usual showing of oblique fibers passing out to the bone.

Figure 1465 is another longitudinal section through the peridental membrane, root and bone showing considerably more disturbance of the tissues and round celled infiltration along the blood vessel routes. This is an excellent example of the early changes which occur in advance of the actual formation of a soft tissue pocket. Round celled infiltration is noticeable along all of the blood vessel-lymphatic routes. The peridental membrane maintains its attachment to the cementum, but none of the fibers appear to pass to the bone, except at the very top and bottom of the specimen. Some may curve around the blood vessels, out of focus in the

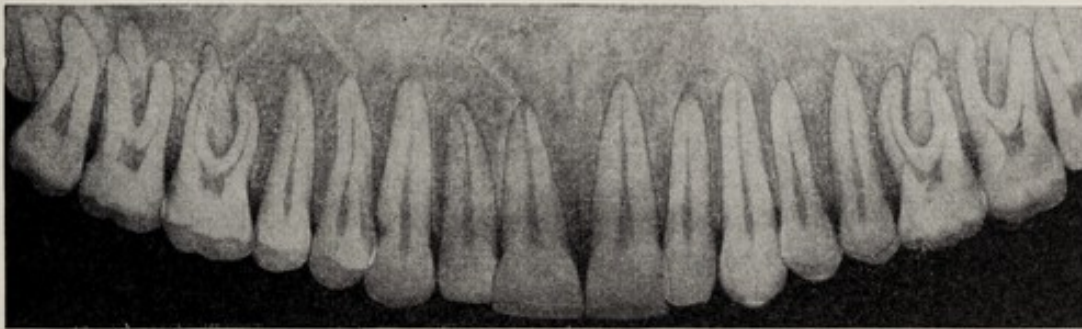


FIG. 1466.



FIG. 1467.

FIGS. 1466, 1467. Panoramic radiographic view of a normal denture, to show especially the height of the bony alveolar septi between the teeth.

microscopic section from which this illustration was made. Some bone has apparently already been resorbed in the center of the field, as resorption is in progress in the bone farther apically.

CEMENTOBLASTS DESTROYED. Suppuration contributes to the destruction of the soft tissues, including deeper penetration of the pocket toward the apex of the root. Eventually all of the pocket tissue, which was attached to the root, is destroyed. The cementoblasts, which lie on the surface of the cementum, are necessarily destroyed at the same time, so that the death of the cementum of the region is inevitable. A slight fringe of tissue may maintain its attachment to the cementum for a time, depending upon the type and virulence of the organisms within the pocket, which must include, at various times, most of those which are either habitual to the mouth or find temporary residence there. Slight suppura-

tions frequently occur without attracting the attention of the patient, or the amount of pus formed may be so great that pressure on the gum will cause it to be discharged from the pocket.

RESORPTION OF BONE. The bone of the alveolar process gradually disappears from the region adjacent to the pocket. This may be due in part to a physiological resorption, which would result



FIG. 1468.



FIG. 1469.

FIGS. 1468 and 1469. Resorptions of interproximal bone as a result of open contacts and impaction of food.



FIG. 1470.



FIG. 1471.

FIG. 1470. Resorption of bone about a lower bicuspid.

FIG. 1471. Resorption of bone about a lower first molar.



FIG. 1472.



FIG. 1473.

FIGS. 1472, 1473. Reproductions of radiographs from the mouth of the same patient, showing deep pockets and separation of the teeth.

from the destruction of the fibers of the periodontal membrane, even though the bone itself were not directly involved by infection. However, the vessels within the bone spaces are usually greatly congested and a leucocytic infiltration of the medullary spaces occurs. Resorption of the bone trabeculae and the pericemental border begin very early. The accompanying illustrations give an

excellent idea of the extensive destruction of bone that occurs as cases progress. Panoramic radiographic views of a normal, healthy mouth are shown in Figures 1466 and 1467. These form a good basis for comparison of the positions of the crests of the alveolar process in the illustrations which follow.

Figure 1468 is a reproduction of a radiograph illustrating a slight resorption of bone between the upper bicusps as a result of infection involving the supporting structures of the interprox-

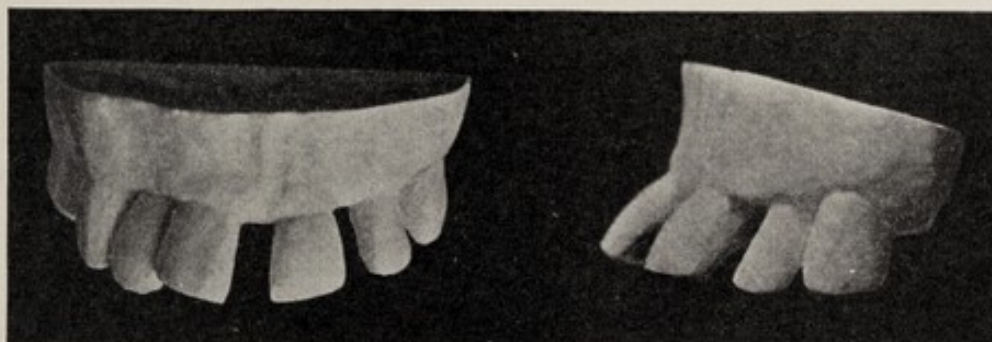


FIG. 1476.



FIG. 1477.

FIGS. 1476, 1477. Two views of a plaster model and a panoramic radiographic view of a case of chronic suppurative pericementitis, showing the protrusion of the upper incisors, also the separation of the teeth. It required a special effort for this patient to hide the teeth with the lips.

imal space. This resulted from a weak contact. Figure 1469 shows a more extensive involvement of the interproximal bone between the upper bicusps on the opposite side of the same mouth, due to an open contact. Figure 1470 shows a fairly deep resorption of bone about the lower first bicuspid, and Figure 1471 a very extensive resorption about the lower first and second molars. Figures 1472 and 1473 are reproductions of radiographs from the mouth of the same patient, showing a number of very deep pockets. In this case the gums and gingivæ appeared to be in excellent condition. The separation of the teeth as a result of the infection may be seen in both illustrations. Figures 1476 and 1477 illustrate an advanced case in which the incisors had separated and protruded.

THE POCKET TISSUE. The tissue forming the pocket is more or less inflamed most of the time. Microscopic sections show from a little to very extensive round cell infiltration. Usually a proliferation of the gingival epithelium occurs in an effort to protect the exposed connective tissue. The epithelium may be sufficiently dense to afford protection, particularly in the case of fairly shallow pockets. As a pocket becomes deeper the epithelial lining is more likely to be inadequate because of repeated infection. The periodontal membrane loses its characteristic special elements, and the adjacent bone of the alveolar process is destroyed; the functions normally performed by the fibers of the periodontal membrane, by the cementoblasts and by the osteoblasts are also lost, and the



FIG. 1478. Advanced case of chronic pericementitis.

cementum becomes a dead tissue. There remains a piece of gum tissue, inadequately protected by epithelium.

Figure 1478 is an example of an advanced case of chronic pericementitis. The illustration reproduces a mesio-distal section through the interproximal space between the lower right central and lateral incisors. The patient was forty-five years of age. At the first examination of this case the periodontal membrane explorers revealed a pocket 4 mm. deep on the distal of the central incisor (to the left) and 8 mm. deep on the mesial of the lateral incisor. There was no suggestion of pus on the flat blade of the explorer when it was removed. No pus was discharged when pressure was made on the gum. It appeared to be a case of so-called "dry-pyorrhea." On the next visit of this patient, there was a

considerable flow of pus when the gums were compressed. This indicates rather definitely that pockets of considerable depth present a constant menace to the health of the patient, because they are subject to frequent reinfections from the fluids of the mouth.

These teeth were removed and a little of the interproximal bone and septal tissue was removed with them. The illustration was made from a mesio-distal section through both teeth and the interproximal tissues. There is a thickened epithelial covering over the detached tissue; and the epithelial downgrowth is apparently attached to the roots. There is extensive round celled infiltration of the connective tissue, while the trans-septal fibers, running diagonally from tooth to tooth, are just beyond the region of active inflammation. The positions of their attachment to the teeth are definitely related to the depths of the pockets, which, on the right side, is near the junction of the middle and apical



FIG. 1479.

FIG. 1479. Imperfect epithelial lining of a pus pocket.



FIG. 1480.

FIG. 1480. Imperfect epithelial pocket lining.

thirds of the root. The bone has been resorbed to correspond with the position of the trans-septal fibers, the crest being higher on the left side than on the right. This is a splendid example of nature's effort to hold the teeth in contact; as the pockets have progressed, cutting off the trans-septal fibers and destroying gradually more and more of the bone, they have been replaced by others which endeavor to perform the same function.

Figures 1479, 1480 and 1481 illustrate several types of inadequate epithelial downgrowth in the effort to line the pocket. The epithelium should be compared with that of a normal gingiva, shown in Figure 1209. In Figure 1479, the tissue which was adjacent to the tooth is on the right side. There is hardly more than a single layer of epithelial cells along the surface, while there are

numerous projections into the connective tissue. One projection, at the lower left, appears to have been sectioned parallel to its long axis, while another, near the top, was cut transversely. Round celled infiltration may be seen throughout the specimen.

Figure 1480 shows a much more extensive proliferation of the epithelium, with very little surface protection. A small portion of the tissue which was adjacent to the root is shown at the upper left corner. There is also considerable round celled infiltration.

Figure 1481 shows a rather unusual arrangement of the epithelium. The right side was adjacent to the root. The slight epithelial covering and the proliferations into the connective tissue may be noted. In this specimen, minute droplets of pus were scattered among and near by the clusters of epithelial cells. Round



FIG. 1481.

FIG. 1481. An imperfect epithelial pocket lining. Droplets of pus were scattered throughout this epithelium.



FIG. 1482.

FIG. 1482. This pocket is lined with good epithelium. All cellular elements were stained dark with thionin and picric acid.

celled infiltration is quite marked. It is of special interest to note the infiltration along the routes of several blood vessels.

Figure 1482 shows a pocket, which has exposed several millimeters of the cementum. This pocket tissue is lined with a down-growth of fairly good epithelium fully to the bottom of the pocket, although there are no epithelial cells in contact with the cementum. There is a slight deposit of calculus on the cementum, which may have interfered with epithelial attachment. This specimen was stained with thionin and picric acid, so that all of the cellular elements appear very dark.

Two regions of resorption may be noted in the cementum, one farther apically than the bottom of the pocket, which has been rebuilt with secondary cementum. The other is exposed in the

pocket and filled with calculus. Presumably the pocket uncovered this region before secondary cementum could be built into it, as such repairs are not made in the presence of fluids of the mouth.

DEPOSITS OF SERUMAL CALCULUS. Deposits of serumal calculus may or may not be present within the pockets on the cementum from which the periodontal membrane has been detached, although they generally are present. The deposit necessarily occurs subsequent to the detachment. The calcific elements are brought to the pocket with the serum which is exuded into the space from the adjacent tissue as a result of the inflammation, in the same manner



FIG. 1486.

FIG. 1487.

FIG. 1488.

FIGS. 1486, 1487, 1488. Teeth with heavy deposits of serumal calculus.

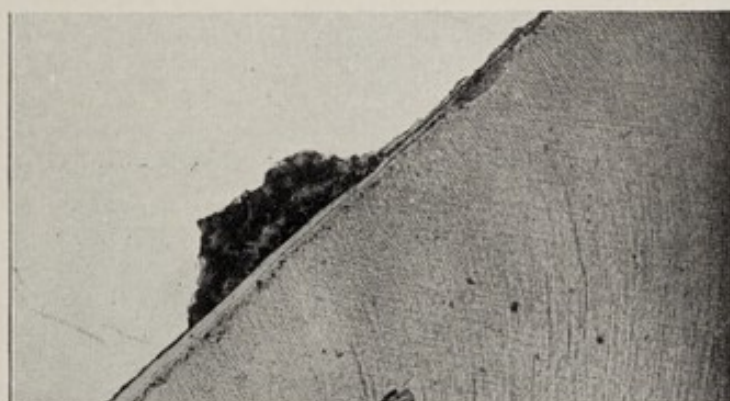


FIG. 1489.

FIG. 1489. Ground section of a nodule of serumal calculus on the cementum. This illustration gives a good idea of the nodular forms generally found in pus pockets.

as deposits are laid down upon the enamel of the gingival crevices. The nature of the deposit is the same; the only difference is in the form. The deposit of serumal calculus occurring on the enamel is, as has been mentioned, usually in the form of a flattened scale, due to the pressure of the gingiva against the deposit while it is soft. Within the depth of a pocket, alongside the root, the soft tissue is not inclined to hug the root closely, and accretions to an original nidus of deposit are likely to be gradually built on and around, forming a nodule. Either the scale or nodular form may be present, although the deposit within the pocket is generally more or

less uneven. See Figures 1486 to 1488, all of which show very heavy deposits on teeth which had evidently received no attention for years. Figure 1489 is a microscopic section of a single small nodule attached to the surface of the cementum. When deposits do occur within these pockets, they serve as an additional irritant to the adjacent tissue, and tend to maintain the inflammatory process. This irritation tends also to increase the deposit.

LATERAL PERICEMENTAL ABSCESS. An acute abscess occasionally develops in the investing tissues of the teeth in connection with the progress of these ordinarily chronic suppurations. This is called a lateral pericemental abscess, because it occurs in the pericemental tissues at the side of the root. The term *lateral abscess* is frequently used to designate this condition. If for any reason

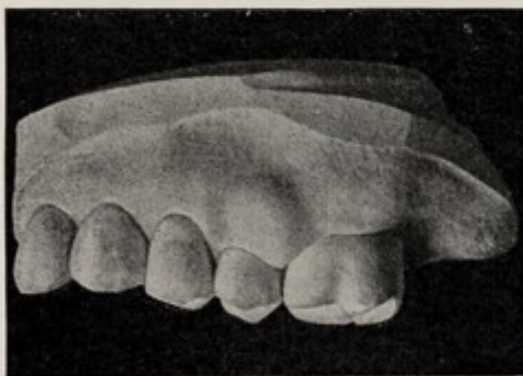


FIG. 1490A.

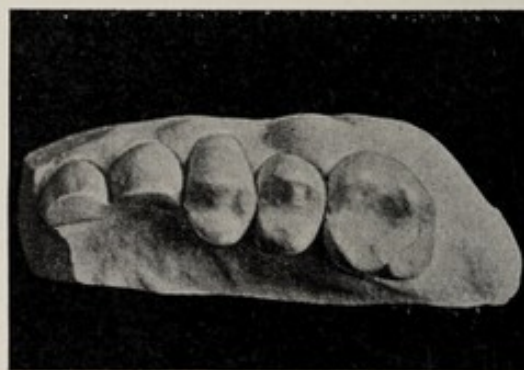


FIG. 1490B

FIG. 1490. A lateral abscess between the second bicuspid and first molar. There was a deep pocket to the distal of the bicuspid root and the pus had penetrated the soft tissue instead of discharging alongside the tooth.



FIG. 1491.

FIG. 1491. Model showing the tissue destroyed by a septal abscess.

the pus, which is formed in the depth of the pocket, is prevented from escaping alongside the root and into the mouth between the crown of the tooth and the margin of the gingiva, it may invade the adjacent soft tissue and develop within a few hours an abscess with all the symptoms of an acute suppuration. Such an abscess is most likely to occur in the deeper pockets, because there is greater opportunity for the pathway to the gingival region to be closed by inflammation. Such an abscess will tend to point on the gum over

the edge of what remains of the alveolar process, or may penetrate the process. Figure 1490 consists of two views of a plaster model of a case which presented with a lateral abscess to the buccal of the upper second bicuspid. Several drops of pus were obtained when the swelling was lanced. The pulps were vital in all of the teeth shown. Figure 1491 illustrates the destruction of tissue by such an abscess occurring in the interproximal tissues. Figure 1497 is also of a case of lateral abscess, in a pocket that was not so deep as the preceding case.

PROGRESS OF POCKETS. Pockets gradually become deeper, often following one side of a root, or only a narrow space, but always progressing toward the apex of the root. The progress is usually slow, yet in some instances a wide destruction of the peridental membrane over the side of a root may occur during a single inflammatory movement. But whether the destruction be slow or rapid, there is a constant tendency to destroy, progressively, toward the apex of the root, rather than to spread around the root, due to the direction of the movement of the lymph, previously mentioned. This process may go on even to the apex of the root of a tooth, while the peridental membrane may remain healthful over other portions of the root. The remaining attached tissue may, and often does, sustain the tooth so completely that it performs the usual service in mastication. It is not until the gradual spreading laterally has broadened the pocket considerably that the tooth becomes loose. Cases are occasionally seen in which an infection about the lingual root of the upper first molar has destroyed practically all of the peridental membrane, including that about the apex, causing the death of the pulp.

In those cases in which there are deposits of serumal calculus on the enamel in the gingival crevice, forming a more or less complete ring of deposit around the tooth, there is likely to be an almost even depth of destruction of the peridental membrane. In such cases, the pocket encircles the tooth, because the inflammation and infection have involved the entire gingiva, and the infection has been transmitted to the peridental membrane by all of the lymphatics leading apically from the gingivæ. The general rule is, however, that the gingival infection is limited to one or both proximal surfaces of a tooth, or to the buccal or lingual surface, and there will develop a narrow deep pocket corresponding to the width of the gingival involvement.

MOVEMENTS OF THE TEETH AS A RESULT OF POCKET FORMATION. One of the very important items in the study of the pathology of these cases is the movement of the teeth which occurs as a result of the swelling and the disturbance of the balance of pull of the various groups of fibers of the peridental membrane. In order to understand these movements, there are several principles which must be considered.

It is important that the general structure of the gingival tissues and the influence of the different groups of fibers which

have been described, be held strictly in mind. The fact that these fibers *hold* one group against another in maintaining the teeth in their proper positions, and that under normal conditions the stresses on the various fibers are accurately balanced, is an important matter, for in this field of pathology much havoc results from the disturbance of the balance of these stresses.

In this it is a general principle that wherever the fibers of the peridental membrane are being destroyed along one side of the root of a tooth, so that their normal hold upon the tooth is broken or much weakened, they fail to offer their normal resistance against movement of the tooth away from the diseased side, or to maintain it in its normal position in the socket. *Therefore, the tendency is for the tooth to move in the direction away from the diseased side.* This is true wherever such a condition occurs and it will be effective unless there is some counteracting force to prevent such a movement. Sometimes deeply interlocking cusps with the teeth of the opposing arch will prevent movement, and many other conditions may prove temporarily sufficient, but in the long run all of these tend to give way.

In these cases there seems to be a relaxation of the tension of the fibers in excess of the actual destruction of tissue. This is apparent from the cessation of the normal tenseness of the fibers during an inflammation which does not destroy them, and from which they recover and again become normal. This is seen most often in irritations of the septal gingivæ from food having been crowded between the teeth. Here the tenseness of the fibers may be so reduced that the teeth will actually stand apart after the food has been removed, yet by care to prevent recurrence of food impaction, the fibers will recover their tone and the closeness of the contact will be restored.

LABIAL MOVEMENT OF UPPER INCISORS. When deposits of ser-
umal calculus on the lingual surfaces of the upper incisors are associated with a pressure pericementitis, or any inflammation which causes the detachment of a portion of the peridental membrane and the hold of the fibers on the lingual side is weakened, so that they offer less than their normal resistance to labial movement, the teeth begin to perceptibly protrude. At first this movement is so slow that the patient will not notice it, and also the disease progresses so slowly and painlessly as to pass unobserved, until the movement of the teeth is considerable. Unless a very critical examination is made the cause of the movement may not be discovered, for in most of these cases the gingivæ on the lingual side give a fair appearance. The tissue is generally thick and heavy at this point, and especially well adapted to conceal the disease going on beneath it. It therefore often happens that the inflammation is overlooked. If, however, a peridental explorer is used to examine the attachment of the membranes of these teeth at the lingual sides of the roots, deep pockets will be found with suppuration, which is cutting away the attachment of the fibers more and

more, weakening or actually destroying the hold of the fibers in the lingual direction. Therefore, in the cases in which considerable destruction of the attachment has occurred to the lingual of the incisor teeth, an amelioration of the conditions may result from treatment, but the movement of the teeth to the labial will not be checked, because the balance of the stresses has not been and can not be restored.

This loosening of the contacts gives the opportunity for injury to the septal tissue of those regions. This leads to suppuration after suppuration, which progressively destroys the supporting structures of the teeth. Finally the entire denture becomes a wreck. Figure 1476 reproduces two views of a plaster model of a case in which both extensive labial movement and wide separation occurred. The panoramic view, Figure 1477, is of the same mouth.

Such a movement of the teeth greatly changes the expression of the face and it is often very difficult to bring the face into correct form with artificial teeth because the residual alveolar ridge will have moved too far forward. Shakespeare seems to have known something of this change of expression, for in one of his plays he says of a woman acting a part: "She is not young, for her upper teeth are already becoming prominent." In this there is a hint of the slowness of this movement of the teeth. For this process to run twenty-five years is no exaggeration. Generally, it is so slow that few dentists have observed individual cases from the beginning to the end. Cases have not been followed with written records which make the facts clear.

These are among the most hopeless cases. The movement of the teeth is continuously progressive. If the anterior teeth are extracted before the separations in the bicuspid region have begun, the loss of these teeth may be averted. The attempt to retain the incisors too long has often been disastrous.

MULTIPLE POCKET FORMATION. It has been observed that when a pocket has formed on the proximal side of the root of a tooth, or of the two teeth on either side of an interproximal space, and has weakened or severed the trans-septal group of fibers uniting the two teeth, it frequently happens that other similar pockets are formed on the proximal sides of the roots of neighboring teeth.

If, for example, there should be an injury to the septal tissue between the first molar and the second bicuspid which weakens the resistance of the trans-septal fibers to a separation of the teeth and a distal movement of the first molar, a similar injury may soon be noted between the first and second molars. The tendency is for the teeth to move away from the diseased side during inflammatory periods and open the contact. The movement is retarded because it is in the line of the arch, instead of to the side of the arch, as in the case of the upper incisors. The first molar will be forced hard against the second molar, and if the stress is sufficient, the second molar will be moved distally very slightly. With the abatement of the inflammatory movement, this stress will be relieved, and the

teeth will return to their former positions. This movement of the teeth will be repeated with each recurrence of the inflammation, and will often cause some slight interference with the intercussing of the teeth with those of the opposite jaw, which tends to cause some movement of the teeth at every closure of the bite. This has its disturbing effect and is particularly liable to drive the first molar back into its former position and occasionally food may be forced between it and the second molar, thus establishing an inflammation of the septal tissue in this space. There is also a lack of resistance to the mesial movement of the second bicuspid, and this tooth exerts a similar pressure against the first bicuspid, and by the same process food will be forced past the contact into that septal space also. As these movements continue there comes a loosening of the contacts of the neighboring teeth, and generally through the arch, by interference with the fibers which form the trans-septal groups. It seems to make little difference what causes the inflammation of the septal tissue first involved.

These inflammatory movements, occurring in the septal tissues, cause these groups of fibers to lose their tonicity. This is seen also in the fibers of the peridental membrane in acute apical pericementitis occurring as the beginning of an apical abscess. The tooth often becomes very loose. This loss of tone is, indeed, the common effect of the involvement of near-by tissues in inflammation. The result is a series of inflammatory reactions affecting a number of teeth, or the septal tissues generally.

Open contacts resulting from movements of teeth may be observed in many of the illustrations. Figures 1468 and 1469 show separations which appear to have been brought about as described above.

ADMIXTURES OF CHRONIC PERICEMENTITIS AND INFLAMMATIONS CAUSED BY SALIVARY CALCULUS.

Deposits of salivary calculus occur frequently during the progress of suppurative pericementitis. Such deposits may occur either before the formation of, or during the development of the pocket without being in any way connected with it, except as a complicating factor.

The appearance of the gingivæ in the two conditions is usually very different. In suppurative pericementitis there is not necessarily any salivary calculus present. Generally there is none, if the cases are seen early. Its general tendency is to destroy the crests of the gingivæ and shorten them as a first effect. This progresses slowly and finally replaces the septal tissue which is destroyed in the process.

In the early stages of conditions leading to the formation of pockets, small points of inflammation are the rule, instead of the broader areas produced by salivary calculus. As pockets are formed, the gingivæ are blunted; their borders, or crests, are thickened. Then if there is an admixture of calculus coming into the mouth

with the saliva, it will be more liable to be deposited where the crests of the gingivæ are thickened than elsewhere.

DIAGNOSIS OF CHRONIC SUPPURATIVE PERICEMENTITIS.

Chronic pericementitis should be classified as a condition of adult life, the incidence increasing with advancing years. It occurs infrequently in the mouths of young adults, for the reason that it is a result of the wear and tear of years in the use of the teeth. Accidents, dental operations, and the loss of teeth, all contribute conditions which promote gingivitis, yet the ability of the tissues to withstand punishment often postpones the time when serious damage occurs.

THE EXAMINATION ; ORDER OF PROCEDURE. In making the examination, the order of procedure should include: (1) A careful survey of the mouth, noting the general condition of the teeth and gums, the care of the mouth by the patient, the occlusion, missing teeth, elongated teeth, and other conditions which will assist in forming an estimate of the problems to be encountered; (2) in advanced cases, inquiry should be made into the general physical condition of the patient, with a record of the age, temperature, pulse, involvement of the cervical glands, excitation of salivary glands, etc. The family history may reveal an hereditary tendency which appears to be a factor in occasional cases; (3) a study of the radiographs to discover resorptions of the bone of the alveolar process, and the positions and relations of the teeth; (4) a survey of the occlusion in detail, including a critical examination of the occlusal surfaces and incisal edges for wear and cusp interference; (5) test of each tooth for possible looseness as described for pressure pericementitis; (6) the conditions of the contacts as tested with a ligature; (7) the condition of the gingivæ; (8) measurements of detachments of the peridental membrane; (9) deposits of serumal calculus; (10) condition of the tissue lining the pocket. As the examination proceeds, further investigation should be made regarding other conditions which might be associated with a detachment of the peridental membrane.

CLASSIFICATION OF CASES. Cases may be divided into three groups, the technic varying slightly for each: First, those in which there are pockets on labial, buccal or lingual surfaces; second, those in which there are proximal pockets; third, those in which there are pockets that entirely surround one or more teeth, which are likely to be of fairly uniform depth. This classification is related to the most frequent cause of the particular condition, as well as the difference in the technic of removing the tissue. Labial, buccal and lingual pockets usually are due to pressure pericementitis, deposits of serumal calculus, or injuries of the gingiva on those surfaces by margins of fillings or crowns. In those cases in which there are proximal pockets, the cause is usually a lack of proper contact. Cases in which there is a general detachment about a

number of teeth are usually due to deposits of serumal calculus, which have formed a band more or less encircling each tooth.

APPEARANCE OF THE GINGIVÆ. The condition of the gingivæ is subject to considerable variation. In some of those cases in which the pockets are very deep, the gingivæ look well. Sometimes they are only a little shortened. They may present no distinct redness except as the result of an occasional more acute inflammation. In other cases the soft tissues are almost constantly inflamed and red. The crest of the gingivæ adjacent to pockets often has a peculiar appearance which is more or less characteristic of the condition. The edge of the gingivæ may be rather smoothly rounded away from the surface of the enamel, and will have an unusually smooth, glossy appearance. This will include only the margin and possibly one or two millimeters of the outer surface. This strip may be slightly bluish in color, in comparison with the adjacent tissue. See the series of illustrations showing the appearance of the gingivæ and gums during the various stages of the progress of this disease, Figures 1493 to 1498.

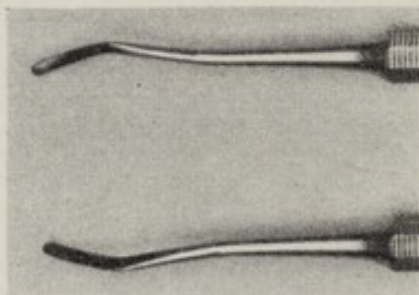


FIG. 1492. Peridental membrane explorers. They have thin flattened blades with slightly rounded edges.

In making an examination of the supporting tissues of the teeth of an adult, one should have at hand a full set of radiographs of the teeth, preferably a set of fourteen films, as these will give more exact information as to the condition of the interproximal tissues, particularly. It is important to note the condition of the crest of the interproximal bone, as a slight resorption may be an early reaction to food impaction.

A pair of especially designed peridental membrane explorers, with thin, slightly curved blades about $1\frac{1}{2}$ mm. in width, with slightly rounded ends, having dull edges, should be used to determine the extent of the detachment of the peridental membrane from the root. See Figure 1492. These instruments may be carried into pockets to measure their depth without injury to the tissues. They are contra-angled, with blades 8 mm. in length. They may be graduated in millimeters so that pocket depths may be accurately measured. In general use, however, one will be able to make sufficiently close measurements by observing the length of that portion of the blade which has not entered the pocket. A root canal plugger

of medium size may occasionally be used to advantage in measuring depths of pockets in positions which can not be conveniently reached with the special explorers. Being flexible, the root canal plugger can be bent to any desired angle.

CONDITION OF CONTACTS. There is nearly always something wrong with a contact whenever there is inflammation of a septal gingiva and inquiry should be made to determine the exact conditions, as directed in the consideration of injuries to the septal tissues.

DETACHMENTS OF THE PERIDONTAL MEMBRANE. These are determined with the peridental explorers and the depth should be separately recorded for each surface of each root. The findings should be checked with the radiographs and should be related to the looseness of the tooth and to the condition of the contacts

RESORPTION OF BONE. The resorption of the bone is best shown by radiographs, although in cases in which considerable progress has been made, the absence of the bone may be easily noted by digital examination. Oftentimes a rather sharp edge of the remaining alveolar process may be felt and the contour of the roots may be made out where they are covered only by soft tissue. The radiogram has, however, demonstrated very clearly that the resorption of the alveolar process begins much earlier and is often more general and more extensive than was formerly believed. Radiographs that are made properly, show very exactly the extent to which the interproximal bone has been resorbed.

After the examination is completed, the pocket depths and other data related to the resorption of bone, should be compared with the radiographs to note whether any resorption shown in the films might have been missed in the instrumental examination, also to learn to what extent the films record resorption on buccal or labial surfaces particularly, which were discovered with instruments. Neither the films nor the instruments alone should be relied upon.

PRESENCE OF PUS. Pus may or may not be present at the time of examination. In many cases, pressure with the finger upon the gum will cause pus to exude from the pocket. This pus is often undergoing putrefactive decomposition and may have a bad odor. In advanced cases, numerous pockets are constantly exuding pus and the products of decomposition, causing the breath to be offensive. Every type of case will be seen, between this and the mildest appearing cases in which no trace of pus may be found, although the explorers may reveal deep pockets.

DEPOSITS OF SERUMAL CALCULUS. Deposits of serumal calculus are present in the majority of cases, although they may be absent in some cases of long standing. They may occur in any position on the denuded surface of the cementum and are generally nodular in form. In some cases they may be observed by retracting the

pocket tissue with an instrument. Generally they are discovered with the peridental membrane explorer, or preferably with a sharp edged pull scaler, passed into the pocket with the edge of the blade held in contact with the surface of the root. There is always at least a little area of denuded cementum between the deposit and the bottom of the pocket.

MOVEMENTS OF THE TEETH. As detachment of the peridental membrane occurs, there is the tendency for the tooth to move in the direction away from the pocket, thus disturbing the occlusion, and in cases of pockets on proximal surfaces, the contact is opened, with resulting lodgment of food debris between the teeth. This is the opposite movement in relation to the injury as compared with that in pressure pericementitis. The further movements of the teeth which may occur have been described.

LOOSENESS OF THE TEETH. Pockets progress in depth toward the apex of the root, rather than laterally, and single rooted teeth are particularly liable to become more and more loosened with the increasing detachment of the peridental membrane. There may be very extensive detachments about one, or possibly two roots, of the multirooted teeth without causing the tooth to be loosened.

MISSING TEETH. A record should be made of the teeth that are missing, with inquiry as to the reason for their removal. A history of the loss of an occasional tooth over a period of years will often give one a better insight into the progress of the case. Also, the record of teeth that are missing is essential in planning the reconstruction of the mouth.

EPITHELIAL LINING OF THE POCKET. The condition of the epithelial lining of the pocket may usually be fairly accurately determined with the dull edged peridental membrane explorers. If one of these instruments is manipulated within the pocket in a definite effort to cause some irritation of the tissue without actually pressing the end of the instrument into it, there will be no bleeding if the pocket has a good epithelial lining. It is the same as though this instrument were used to scrape the surface of the gum tissue. If the pocket tissue bleeds on the slightest touch or as a result of moderate irritation, it is a certain indication that there is insufficient epithelial protection, and the tissue is inflamed.

COMPLAINT OF PAIN. The complaint of pain in connection with these cases varies greatly. The wide difference in the sensitiveness of the septal tissue to food impactions has been mentioned. As the depth of pockets increases, patients are more likely to complain of soreness of the teeth to the stress of mastication, than of pain. Cases may progress to the stage where many teeth are hopelessly involved without the least pain; on the other hand, there will be acute pain in many cases during a period of acute inflammation. Both the tenderness to touch and the pain are more apt to be complained of when the inflammation has involved the deeper

tissues, near the apex of the root, and the swelling has caused the tooth to be slightly lifted in its socket. The opposing teeth strike it every time the mouth is closed, and this materially increases the inflammation, often causing the tooth to become extremely painful and tender to touch.

ENLARGEMENT OF CERVICAL GLANDS. During the progress of this disease there is apt to be swelling of the cervical glands, which drain the region of the mouth. In some cases, in which there is a very slight inflammation about the teeth, there may be considerable enlargement of the glands of the neck, while in others, in which the mouth infection is extensive, none of the cervical glands can be palpated. The swelling of these glands should always suggest the danger of systemic infection. However, the absence of enlarged cervical glands does not indicate that there is no systemic danger, because most of the secondary infections are probably hematogenous.

EXCITATION OF SALIVARY GLANDS. There is an almost continuous excitation of the salivary glands in cases in which there are a number of suppurating pockets. Some patients state that it is necessary to use a napkin at night to protect the pillow from this flow.

LATERAL PERICEMENTAL ABSCESS. In cases of chronic suppurative pericementitis in which the pockets are rather deep, an acute infection may occur in the deeper portion of the pocket and, because of some interference with the free discharge of pus at the gum margin, an acute pericemental abscess may develop. The gum will be swollen, together with other symptoms of acute infection, and slight pressure on the gum may cause intense pain. The tooth will usually be very tender to the touch. If a periodontal explorer is carefully placed in the pocket and the tissue is slightly retracted from the root, pus will be discharged. Such an abscess is in no way related to the death of the pulp; the pulp may be vital.

DIFFERENTIAL DIAGNOSIS FROM ACUTE PERIAPICAL ABSCESS. A lateral pericemental abscess may be mistaken for an acute periapical abscess. In making a differential diagnosis, an examination should be made to determine whether or not the pulps of the teeth are vital. If so, this excludes periapical abscess. A periodontal membrane explorer should be entered between the gingivæ and the crown and passed alongside the root until it passes into the depth of the pocket. If the tissues are thus shown to have been detached to a depth corresponding to the position of the abscess, the diagnosis is clear.

Another related condition of extreme soreness occurs when a pocket is so deep that the periodontal membrane is being stripped from the apex of the root, or when the apex of the root is very closely approached. In these cases the symptoms closely simulate those of acute periapical abscess, and if the pulp of the tooth is alive, it generally dies as a result of the extension of the suppura-

tive process. This happens more frequently at the apex of the lingual root of the upper first molar than elsewhere.

ILLUSTRATIONS OF SEVERAL STAGES OF GINGIVITIS AND PERICEMENTITIS.

This series of illustrations was prepared in color in the endeavor to show the appearance of the gingivæ and gums during the various stages from a slight gingivitis to a deep pocket and the formation of a lateral abscess. The slightest redness and swelling, as shown in Figures 1493 and 1494, should be investigated immediately and treatment should be instituted to eliminate the cause.

Figure 1493. There is a slight inflammation of the septal gingiva between the first and second molars. This was due to leakage of food through a weak contact; there was no decay. It should be recognized that every such inflammation may be the forerunner of a case of chronic suppurative pericementitis, which may involve the entire denture. Here is the opportunity to *cure the gingivitis and prevent the pericementitis*.

Figure 1494 is an occlusal view of a case similar to that shown in Figure 1493. In this, food impaction occurred between the bicuspid. There is a little swelling of the tissue of both buccal and lingual embrasures with a depression between. A simple operation to restore a proper contact will result in the prompt disappearance of the gingivitis. If neglected it will progress to the condition shown in Figures 1495, 1496 and possibly 1497.

Figure 1495 is a buccal view of a case in which an open contact permitted food lodgment and resulted in the destruction of much of the septal tissue and detachment of the peridental membrane from the distal surface of the cuspid. This case has already progressed so far that a cure is out of the question.

Figure 1496 is a case in which the open contact has resulted in the complete destruction of the septal gingiva and the formation of a deep pocket between the first molar and second bicuspid. The trans-septal fibers have all been destroyed and there is little hope of maintaining a contact. The inflammation between these teeth may eventually cause neighboring contacts to open, as described in the text.

Figure 1497 shows a lateral abscess, which occurred in a case similar to that shown in Figure 1496. Instead of the pus escaping alongside the tooth; it penetrated the soft tissue and an abscess developed. The swelling caused the soft tissue to fill the septal space. After the acute symptoms have passed, the tissue of this space will resemble that shown in Figure 1491.

Figure 1498 is a case in which an open contact between the upper central and lateral incisors had caused a recession of the septal gingiva. Such cases usually progress to the destruction of the peridental membrane, if the contact is not restored early.

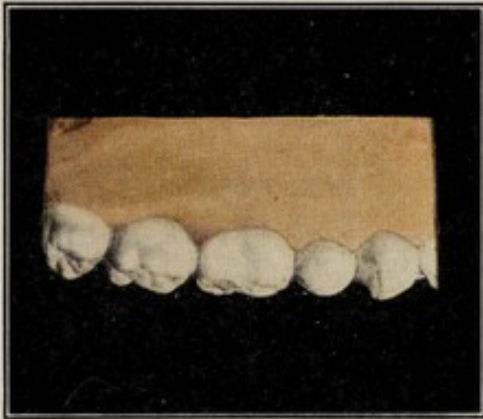


FIG. 1493.

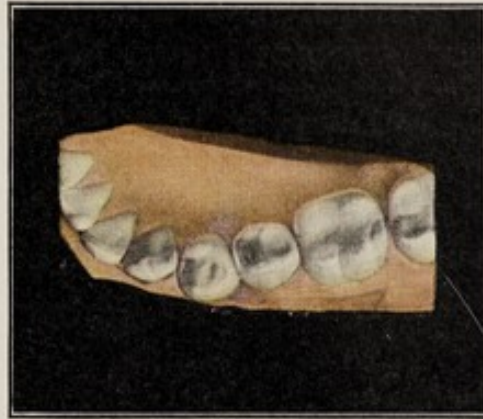


FIG. 1494.

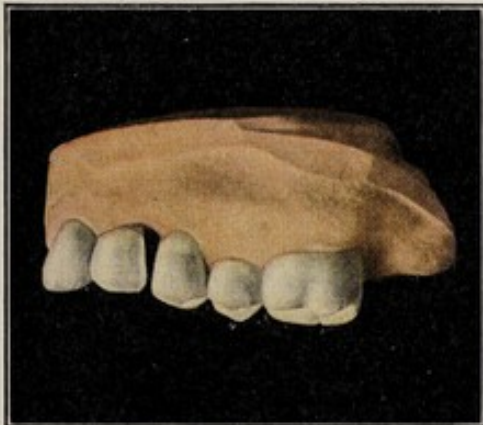


FIG. 1495.



FIG. 1496.



FIG. 1497.

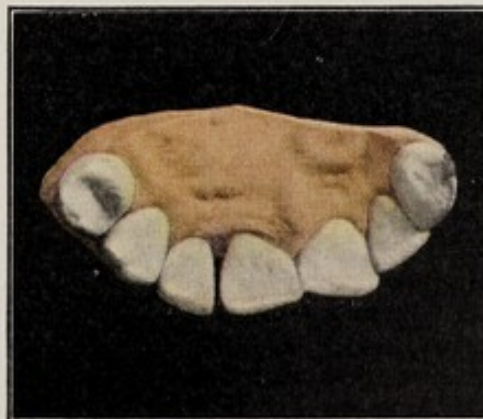


FIG. 1498.

FIGS. 1493 to 1498. Illustrations of several stages of gingivitis. For descriptions, see text.

RECORDING THE EXAMINATION.

Directions for recording examinations of the supporting tissues, together with related data, are given in Volume I, pages 63 to 76 inclusive. The chart to be used as a guide is on page 65 of the same volume. In practice, a copy of this chart should be at hand for convenient reference. In order that the method of recording may be more closely associated with the diagnostic symptoms and signs of the diseases of the investing tissues, a special examination card has been prepared with entries for those conditions most frequently encountered. This card is reproduced in Figure 1499, and the conditions recorded are as follows:

GENERAL SURVEY. The occlusion is normal, patient care medium, immunity to caries high, the gingivæ show many regions of inflammation. The patient is 45 years of age.

Both upper third molars, and the lower right first molar are missing; otherwise the dentition is normal. Starting with the upper right molar region, there is an improper contact (35) between the second bicuspid and first molar and an open contact (26) between the bicuspids, for both of which a crown on the second bicuspid is responsible. There are pockets of 4 mm. depth on the mesial side of the first molar, 5 mm. on the distal of the second bicuspid, 4 mm. on the mesial of the second bicuspid and 3 mm. on the distal of the first bicuspid. The gingiva to the buccal of the second bicuspid is inflamed by the ill fitting margin of the crown (37). This tooth is loose (46) and there is a chronic periapical abscess (C). There are deposits of serumal calculus in the gingival crevice on the lingual surface of the four upper incisors (19), and pockets 2 mm. deep on the lingual of both central incisors. A memorandum in the center oval indicates "scattering" deposits of serumal calculus, which means that they are not all recorded, but should be looked for on all of the teeth with the scalers at the proper time. The cusp of the upper left cuspid is worn (98), the position being indicated by a circle, which would ordinarily be marked with blue. This tooth has moved slightly to open its contact with the first bicuspid and the septal gingiva is inflamed (23). There is inflammation of the septal tissue between the upper left second bicuspid and first molar, due to a mesio-occlusal restoration in the first molar which does not make contact (26). There are pockets 3 mm. and 4 mm. deep, as indicated. The pulp of the first molar has been removed and there is a good root filling with no showing of rarefaction of the apical bone (R). If a tooth had a root filling and was also abscessed, it would be marked R C.

In the lower arch, the right first molar is missing, and as a result, the second molar has moved mesially, opening its contact with the third molar, which has caused an inflammation of the septal tissue (21), also proximal pockets 4 mm. and 5 mm. deep. The second bicuspid has moved distally for the same reason (21) and with similar results. In addition to the pockets, there are deposits of serumal calculus on both roots, and pus was present. The lower incisors have pockets on the proximal and labial surfaces, the depths of which are indicated. The lower right central is slightly loose (46—). Deposits of salivary calculus are recorded on the lingual surfaces of the incisors and cuspids (18). The lower left first molar is slightly loose (46—), tender to pressure occasionally and pus was present in pockets 7 mm. and 6 mm. deep, on the mesial and distal sides respectively. Both contacts are open (28) and there are pockets of 5 mm. and 4 mm. depth on the proximating teeth. There is a weak contact between the second and third molars, which has caused a gingivitis and pockets 3 mm. and 4 mm. deep.

The program to be followed in the treatment of this case will be given under the heading of the Order of Procedure in Treatment, in connection with Figure 1516.

NAME *Gallagher John H* ADDRESS *3765 North main St*
 NUMBER *3024* TEL *North 2946* NPIR City *1*
 BUS. TEL *Main 3872* EXAM. NO. *98* DATE *9-16-34*
 AGE *45* NEXT EXAM

RIGHT LEFT

OCCLUSION *N* Scattering *19* CRIES *123* GINGIVAE *123*
 PATIENT CARE
 REFERRED BY *Pus* / *F occasionally* *Pus*
 REPORT TO *tender to pressure*

REP. ORT. RAY. ENT. ME. MO.
 FIL. ED. PHO. TEL. FOR. W.D.

FIG. 1499. Recording examinations of the investing tissues. For description of this record, see text.

PHYSIOLOGICAL REACTIONS OF SUPPORTING STRUCTURES TO DAMAGE INFLICTED IN CHRONIC PERICEMENTITIS

The physical functions and physiological relations of the supporting structures of the teeth have been discussed, also the damage caused by gingivitis and pressure pericementitis. Before giving consideration to the treatment of chronic pericementitis, it should be profitable to consider the possible *physiological reactions* of the tissues, which constitute nature's effort to eliminate the infection, to possibly prevent its recurrence and to restore such measure of function as may be possible under the circumstances. In some cases, it will be found practicable to so direct the treatment as to aid nature; in others, nature's limitations will suggest more radical procedures.

EPITHELIUM.

The reactions of the epithelium, in its efforts to afford protection to exposed connective tissue, are of great importance in the treatment of all diseases of the gingivæ and peridental membrane. It is the one tissue that effects actual and permanent healing after detachment of the peridental membrane occurs.

RECOVERY FROM GINGIVITIS. In all cases of gingivitis, except the limited number in which the resistance has been lowered by some systemic condition, the recuperative ability of the tissues becomes apparent as soon as the cause of the irritation is removed. When these tissues have been compressed or otherwise damaged by trauma or infection, or both, without detachment of the peridental

membrane at the cemental line, they will usually regain normal health and form very promptly, after the source of the inflammation is removed. The gingivæ themselves require no treatment. Also, the connective tissue projections into the epithelium provide a blood supply for the quick repair of surface injuries or the rebuilding of the epithelium when considerable portions have been destroyed. A gingiva which is swollen and bleeds on slight irritation may fully recover within forty-eight hours.

CREVICE EPITHELIAL PROJECTIONS ATTACHED TO CEMENTUM. The epithelium of the gingival crevice may project itself into the peridental membrane along the surface of the cementum, as a reaction to gingival inflammation. See Figure 1211. It reacts in the same manner in cases of recession of the supporting structures, in which, apparently, there is no inflammation, as illustrated in Figure 1212. This appears to be nature's way of preparing for a possible detachment of the peridental membrane from the cementum. However, in the movement, the epithelium will be projected to, but not beyond, the level at which principal fibers of the peridental membrane are attached to the cementum.

PROLIFERATIONS TO PROTECT POCKET TISSUE. When detachments of the peridental membrane occur at the cemental line, connective tissue is exposed and the epithelium of the gingival crevice proliferates to grow over and protect this connective tissue. This effort may or may not be successful, depending in part upon the promptness with which the irritation is removed and in part upon the maintenance of cleanliness of the pocket for a sufficient time. In cases in which the detachment is slight, the downgrowth of the epithelium will usually be sufficient to provide the same protection to the connective tissue as is normally afforded by the epithelium of the gingival crevice. Nature will completely repair the damage. However, there will probably be a depression in the line of attachment of the peridental membrane; if so, the corresponding region of the gingiva will recede a distance about equal to the detachment, thus forming a slight notch or depression in the crest of the gingiva.

CHARACTER OF EPITHELIUM IN DEEP POCKETS. When detachments occur to considerable depth before they receive attention, it may become impossible to control the infection for sufficient time to permit a good growth of epithelium to reach the bottom of the pocket. The quality of the epithelium may then vary greatly; there may be a single layer of cells on the surface, with or without projections into the connective tissue, the cells may be disposed in almost any arrangement, other than the compact layers which are necessary to afford reasonable protection to the underlying tissue. In such cases, there will be round celled infiltration of the connective tissue, as a reaction to bacterial invasion. There may be minute droplets of pus scattered among the epithelial cells so that it seems questionable whether such a downgrowth

does more harm than good. When this condition prevails, the tissue will bleed when a periodontal explorer is manipulated gently within the pocket. See Figures 1479, 1480 and 1481.

PERIDONTAL MEMBRANE.

ATTACHMENT TO CEMENTUM MAINTAINED IN PRESSURE PERICEMENTITIS. The attachment of the periodontal membrane to the cementum is generally not disturbed in cases of pressure pericementitis. The bone is resorbed, as described, and the outer ends of the fibers remain scattered throughout the soft tissue of the gum in much the same manner in which those of the gingival group normally extend into the gingivæ. They do not afford much support for the tooth, but the vitality of the cementum is maintained so long as the periodontal membrane is attached. These fibers may gradually disappear as a result of continued irritation or infection.

DESTRUCTION IN CHRONIC PERICEMENTITIS. In cases of chronic pericementitis, when a break occurs in the periodontal membrane, along the lines of the blood vessels, several tissue changes occur, which have been described. The short ends of fibers attached to the cementum, also the cementoblasts may remain vital for an indefinite period, depending upon the conditions as to infection, etc., which may develop within the pocket. The outer ends, which are attached to the bone, will be resorbed because they have been rendered functionless and no longer contribute to the support of the tooth.

WHEN DETACHED FROM THE CEMENTUM. When the fibers of the periodontal membrane are detached from the cementum, and remain so for some time, they are replaced by granulation tissue. They may disappear because they are no longer able to contribute to the support of the tooth. The cementum becomes a dead tissue, and reattachment can only occur through the formation of a new layer of cementum on the surface of the root. Theoretically, this may be accomplished by gradual projections from the neighboring attached tissue. In doing this "the tissues must lie in physiological contact with the cementum and the connective tissue cells must be actively functional."* When the denuded cementum has been bathed in pus for a long time or has been otherwise contaminated, the tissue cells can not lie in contact with it and be actively functional; in fact, these cells would be destroyed as a result of such contact. This question will be discussed further in considering the repairs of cementum.

ALVEOLAR PROCESS.

CONDITIONS OF BONE REGENERATION. It has already been pointed out that the alveolar bone, which forms the sides of the socket, is always resorbed in regions corresponding to the detach-

* Noyes Histology, p. 162.

ment of the peridental membrane from the cementum, or to a break in the continuity of the fibers as they pass from the cementum to the bone. This alveolar bone will not be rebuilt unless it can give support to fibers of the peridental membrane, the inner ends of which are attached to the cementum. Therefore the regeneration of alveolar bone in these cases is dependent on the prior lateral extensions of the peridental membrane and the laying down of new cementum.

This is in definite contrast to cases of pressure pericementitis, in which the bone is destroyed first, while the fibers, or at least the inner portions, maintain their cemental attachment. Under these conditions, the bone may be rebuilt if the tooth is stabilized and the tissues are free from irritation or infection.

It will, therefore, be noted that the continued existence or the rebuilding of alveolar bone about the sides of the root is dependent upon the integrity of the principal fibers of the peridental membrane, and the continued existence of these fibers is based upon the maintenance of their attachment to the cementum. The cementum is thus the tissue of first importance in chronic pericementitis and its condition is the key to the situation, so far as the regeneration of both the peridental membrane and bone are concerned.

CEMENTUM.

CAN NOT INITIATE PROCESS OF REPAIR. The cementum, being an entirely passive tissue, due to the fact that it has no circulation of blood, can initiate no process of repair. It does not react to injury or infection. The cementum is also without nerve connections, and is therefore without sensation. In these respects it is comparable to the finger nail. The latter has the advantage in that it is continuous growing and moves over the surface to which it is attached in such a way that a damaged portion is removed by the process of natural growth. The cementum may also be said to be continuous growing, yet it becomes thicker in the direction of cementoblastic activity, while the finger nail receives additions at the inner end as the outer end is extruded. There is no provision for the exfoliation or extrusion of dead cementum.

REPAIR OF CEMENTUM RESORPTIONS. The cementum is subject to resorptions under many conditions. These regions of resorption are generally repaired by the activity of the cells of the peridental membrane, which lay down secondary cementum within the cavity. However, such repairs are never made except in the presence of complete asepsis, and practically all occur in regions which are entirely surrounded and enclosed by healthy tissue and are, therefore, neither exposed to the fluids of the mouth, nor to apical infections occurring as sequellae of the death of the pulp.

LITTLE LIKELIHOOD OF REUNION OF SOFT TISSUE POCKET. When a break occurs in the peridental membrane as a result of infection,

the extent and rapidity with which the tissues are destroyed must vary, depending upon the types of infection. It seems possible that the fringe of tissue attached to the cementum, or at least some part of it, might retain its vitality for a considerable time and thus maintain the vitality of the cementum. A reunion of this tissue with the adjacent tissue might occur under the same conditions under which other severed soft tissues unite. However, the amount of this tissue is so slight that it should not be expected to survive in the presence of an active pyogenic infection. Attention has been called to the fact that the entire thickness of the peridental membrane is on the average less than the diameter of a fine hypodermic needle. In the very large majority of cases, the progress of the disease is so slow that the peridental membrane appears to be completely stripped from the cementum to the full depth of the pocket. Whatever remains must generally be insufficient to be worthy of practical consideration in treatment.

POSSIBILITIES OF REATTACHMENT OF POCKET TISSUE TO DENUDED CEMENTUM. Two methods are conceivable by which pocket tissue might be reattached to the cementum: The first is by the laying down of a new layer of cementum over that which is denuded. To accomplish this, the connective tissue cells must lie in contact with the dead cementum and function actively. They can not do this, if the cementum has been bathed with pus for a considerable time, as the soft tissue cells would be destroyed. Also, there is no record of a new layer of cementum being laid down in an area exposed to the fluids of the mouth. Figure 1744 illustrates a rare case in which the broken end of a fractured root was completely built over with a layer of new cementum.

The second method is by an effort to cut away the contaminated portion of the cementum. Here again, to secure reattachment of the peridental membrane, it would be necessary that a new layer of cementum be deposited in the presence of the fluids of the mouth. This is theoretically possible, but has never been shown to have occurred. The other possibility is an attachment such as occurs in the case of the planted tooth, by the gradual resorption of the root and the building of bone into the resorbed excavations. It must be remembered, in this connection, that no bone of the alveolar process remains adjacent to the position of the pocket. The situation would therefore require that new alveolar bone be formed in a region where there are no fibers of the peridental membrane.

KEY TO TREATMENT. In view of the above statements, it seems logical to state that, notwithstanding the fact that reattachments of the peridental membrane to the cementum may possibly occur over very limited regions, for all practical purposes, *the key to the treatment of suppurative pericementitis is in the statement that suppurative detachments of the peridental membrane are permanent detachments.*

HISTO-PATHOLOGICAL STUDIES OF PLANTED TEETH IN DOGS*

The principal of coordinate physiology controlling the relations of the cementum, peridental membrane and alveolar process are best determined by histo-pathological studies of the investing tissues in repair processes, after separation of these tissues by any cause, as for example, in cases of planted teeth.

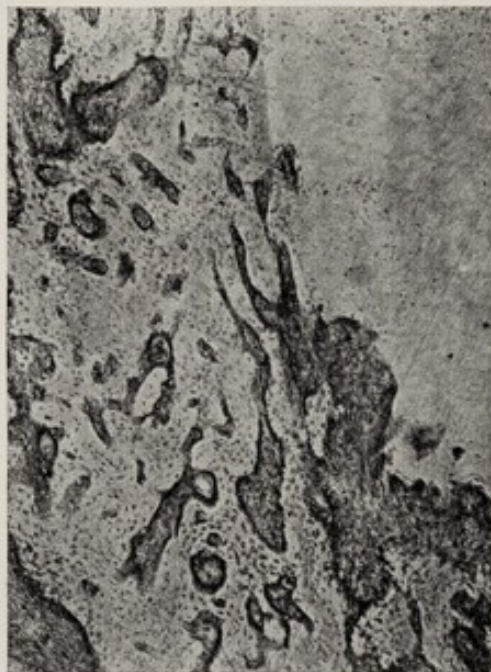
The different classes of planting operations have an accepted nomenclature:

Replantation is used when teeth are dislodged by accident or extracted purposely and replaced in their own sockets.

Transplantation is used when a stranger tooth is placed in the socket of a tooth just removed.

Implantation is used when a tooth has been removed at some former time and a new socket is cut in the residual alveolar process or ridge to receive a stranger tooth.

R



B

FIG. 1500.

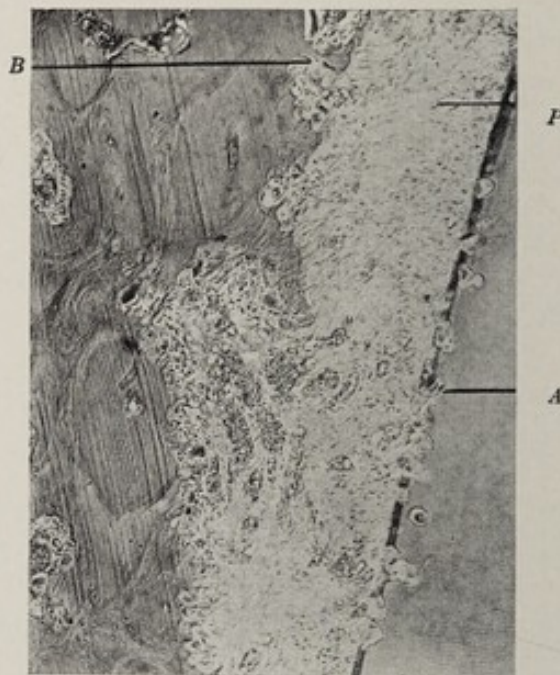


FIG. 1501.

FIGS. 1500, 1501. Experimental replantations of dogs' teeth, showing resorptions of roots. In Figure 1500, the root is marked R, the bone B. In Figure 1501, resorption of root, A; resorption of bone, B; peridental membrane P. Lundquist.

EXPERIMENTS ON DOGS. The idea that the peridental membrane becomes revived to any considerable extent for long periods of time is without foundation of fact. This is demonstrable with both transplanted and implanted teeth. In cases of replantation the peridental membrane is all eventually destroyed. The rule is that a partial destruction of the root occurs before there can be fixation of a planted tooth.

*Brief summary of section on planted teeth, from thesis entitled "A Study of the Process of Regeneration Following Injuries to the Teeth and Their Investing Tissues," by G. R. Lundquist in partial fulfillment of requirement for the masters degree, Northwestern University Dental School, 1935.

History records every degree of success and failure that can be imagined, so far as initial attachment of tissue to the root is concerned. In this particular study a considerable number of cases were failures from the start; suppuration occurred in the socket about the tooth, and it was necessary to remove it within a few days or weeks. This seems to support the belief that no resorptions occur and no attachments are made in regions of suppuration. In other cases the soft tissues healed about the teeth, and they became tight or fixed immovably in their sockets. Such teeth, which seem to present the most perfect results, are usually lost within a few years by a progressive resorption of the tooth root and its replacement with bone.

Figure 1500 is a longitudinal section in the apical region of a lateral incisor showing bay-like excavations in the surface of



FIG. 1502.

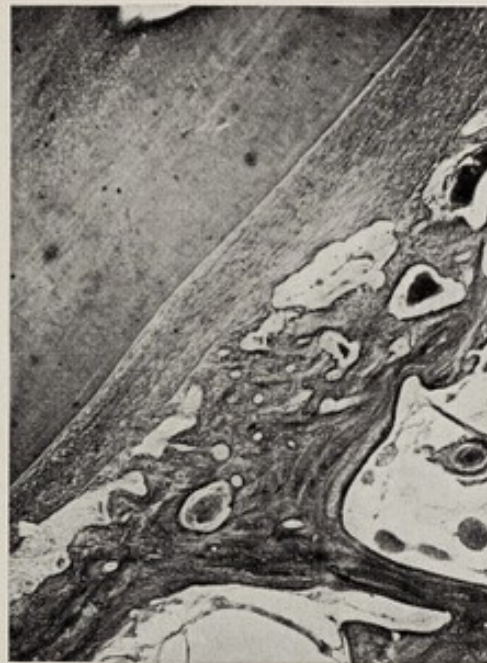


FIG. 1503.

FIGS. 1502, 1503. Experimental replantations of dogs teeth, showing resorptions of roots. Lundquist.

the root, into which projections of bone have been built. By this process the tooth was stabilized.

Figure 1501 is a longitudinal section in experimental replantation in a dog after six days. Resorption is noticeable at different points on both the alveolar bone and the cementum of the root. Figure 1502 is a mesio-distal section of a similar replantation of a central and lateral incisor of thirty days duration, showing progressive resorption of the roots of both teeth. Figure 1503 is a higher magnification of a section similar to Figure 1500, showing the possibility of fixation by direct apposition of bone

to the cementum of the tooth root. There are several regions in which the bone and cementum are united.

When teeth are extracted and immediately replanted, a complete separation of the investing tissues takes place. As a result: (a) the circulation insofar as the tooth and its adherent tissues are concerned, is completely interrupted; (b) the re-establishment of circulation may be retarded by inflammation resulting from gingival or apical involvements; (c) the immobilization of the tooth during the early stages of rapid resorption and repair prevents the possible stimulating effects on repair which functional use might provide; (d) the tooth becomes in consequence a foreign body; (e) progressive resorption of the root is followed by the building in of bone; (f) the tooth participates only passively in this process. These factors constitute a major injury which the tooth does not survive.

RADIOGRAPHS OF A CASE OF REPLANTATION IN HUMAN MOUTH.
A radiograph of the upper left first bicuspid revealed an apical rarefaction. The tooth was extracted and attached to the root end was a sack of granulation tissue. With the consent of the patient the root canal was treated and filled while the tooth, which was wrapped in gauze and kept moist with normal saline solution, was held by the fingers of the operator. The apical region was then resected to eliminate that portion of the root which had the granulation tissue attachment. The tooth was then carefully washed in normal saline solution and replaced in its own socket and a ligature was used to stabilize it.



FIG. 1504.



FIG. 1505.



FIG. 1506.



FIG. 1507.

FIGS. 1504 to 1507. Replantation of an upper first bicuspid. Fig. 1505 shows the case one month after replantation, Fig. 1506 three years later and Fig. 1507 six years later. *Lundquist.*

Figure 1504 shows this upper left first bicuspid with rarefaction in the apical region. Figure 1505 shows one case one month later. A gold inlay had been made to restore the lost portion of the crown. Figure 1506 shows the case three years after replantation. A progressive resorption of the root is clearly demonstrable. Figure 1507 shows the case at the end of six years. The resorption process had progressed to such an extent that little of the root remained. Eighteen months later the tooth was lost while chewing a carmel.

Treatment of Chronic Suppurative Pericementitis

ILLUSTRATIONS: FIGURES 1508-1541.

FIRST consideration should be given to the relationship which such foci of infection bear to general systemic conditions. This being so, the first rule of practice must be to protect the patient's health from this source of toxemia or actual systemic infection. The question of the service which teeth may be giving in mastication should have no weight as against the general health. No set of natural teeth, with many pockets about their roots, is enough better in mastication than artificial teeth, to justify one in jeopardizing the health of the individual by their retention.

Consideration of the general health should not be based on the apparent or even the actual physical condition of the particular patient at a given time, but rather on the danger to his future health. Many of the secondary systemic lesions are incurable when they have progressed sufficiently to be recognized. Therefore, the dentist is not justified in permitting patients who are apparently well to retain foci of infection in their mouths. The resistance of some individuals may be sufficient to withstand these infections for many years, possibly to old age, yet no one can be certain at any given time that such a person is really free from injury.

Nowhere in the practice of dentistry is there better opportunity for the exercise of good judgment, based on experience and carefully recorded observation, than in determining the course to be pursued in the management of these cases. The retention of teeth which should be extracted often interferes with the effectiveness of preventive measures as applied to other teeth. It is especially urged that a plan must be determined upon by which the particular mouth will be kept free from infection.

The key to the treatment of suppurative pericementitis is in the statement that suppurative detachments of the peridental membrane are permanent detachments. The denuded cementum is the continuous irritant and the inability of the epithelium to maintain a satisfactory covering for the connective tissue in the depth of the pocket, permits continuous or recurrent infections.

PREVENTION.

All that has been said heretofore relative to the treatment of the various forms of gingivitis is essentially preventive treatment of chronic pericementitis. The inflammations of the gingivæ, as such, are of little consequence and require treatment principally for the purpose of preventing involvement of the deeper tissues.

It will be realized that the treatment of the beginnings of disease of the gingivæ belongs to the general practice of dentistry. The greatest hope for the future is in the application of preventive

treatment by all dentists, rather than in the use of palliative treatment by specialists.

Up to the present time but few dentists have applied treatment to prevent chronic pericementitis; the large majority having deferred treatment until after the pockets have been formed. As a first effort in practice this must be exchanged for a systematic scheme of observation for the detection of the conditions which cause detachments, and the correction of these before they have done serious harm. It has been pointed out that a very large percentage of all regions of gingivitis are caused by operating which is directly abusive to the soft tissues, or which, on account of lack of care in the finer details, is indirectly injurious. The highest type of preventive treatment, therefore, will be the exercise of the finest care to do each operation so well that the soft tissues will suffer no injury. This may only be done as the result of a careful study and training by each dentist for himself.

Notwithstanding the fact that, apparently, as far back as the record may be followed, more teeth have been lost from disease of their supporting structures than from dental caries, ample evidence is now accumulating that the incidence of chronic pericementitis is being tremendously reduced by all practitioners who are applying well systematized methods of procedure and patient management. As dental caries has been brought under better control, the problem of preventing the diseases of the investing tissues has been greatly simplified.

TREATMENT.

Cases present with varying degrees of involvement of the supporting structures, from a mouth in which there is a single shallow pocket, to one in which there is every degree of tissue change that has been discussed, including the most extensive destruction that can occur about the teeth while they still remain in the mouth. In cases in which there are several pockets of considerable depth, there may be a history of one or two teeth that had been extracted because they became very loose or were tender to pressure; there will likely be other pockets of moderate depth and a few that are very shallow. In other locations, inflammations of the gingivæ without detachments of the peridental membrane will be found. Any of these may be complicated by deposits of serumal calculus. The investing tissues about other teeth will be normal and may present the picture of perfect health.

These wide variations in conditions in the same mouth are expressions of the extreme chronicity of this disease. In cases in which several teeth have been lost, the complete history might cover twenty-five years or more. One should learn to visualize and understand this history in the examination of a single complicated case. Every type of the disease from the slightest gingivitis to the tooth which has lost most of its supporting structures and is so loose that it might be removed with the fingers, may be

seen in the same mouth. In some cases, in which the extraction of teeth was too long delayed, there is evidence of even further injury, as shown by the excessive destruction of bone, which has left the patient without a sufficient residual alveolar ridge to support a denture. In the study of cases and the planning of treatment, it is of the greatest importance that each difference in tissue change, as seen about various teeth, should be recognized as one more step in the progress of this disease as applied to each and every tooth. The history of a quarter of a century for a few teeth is in process of repetition, in varying stages, about others.

METHODS OF TREATMENT.

Three principal methods of treatment are available; all are based on the condition of the tissues of the particular pocket and their possible reactions, as will be noted in the following paragraphs:

REMOVAL OF CAUSE AND CLEANLINESS. This method applies primarily to cases in which the pockets are shallow. It does not contemplate reattachment of the pocket tissue to the cementum, although that may possibly occur, depending upon the elapsed time since the detachment, the type of infection and the condition of the cementum. It is based on the normal reactions of the gingival epithelium: (1) to quickly recover when the source of irritation is removed or corrected; (2) to proliferate apically to cover the connective tissue exposed by the detachment. Any of the causes of gingivitis, which have been mentioned, will become a cause of detachment of the peridental membrane if it is allowed to continue for a sufficient time. Therefore, everything that has been said regarding the treatment of the various forms of gingivitis becomes a part of this method of treating chronic pericementitis. This should always include a search for and the complete removal of deposits of serumal calculus. In addition, it is necessary that the epithelium of the gingival crevice shall have the best possible opportunity to proliferate and build a substantial protection for the exposed connective tissue. The most important factor to this accomplishment is the cleanliness of the region. Such a growth will generally occur within about ten days, if reasonable cleanliness is maintained. The ideal program is the twice daily irrigation of the space with salt solution, using the rubber bulb syringe. This may be done by the patient or the dentist, or by both. If the patient is to be instructed with this care at home, he should be given a syringe of the type shown in Figure 1541, and should be carefully instructed in its use. Many patients will do this faithfully for as short a period as two or three weeks. A more satisfactory plan for the run of cases is to ask those patients who can conveniently do so to call at the office once a day in order that the dentist may thoroughly irrigate the space; this requires but a five minute appointment. The patient should also use his syringe at home once a day. The dentist should see the case as frequently as may be arranged during this period of irrigation.

The time required for a satisfactory repair of the injury will vary with the physical condition of the patient, the depth of the pocket and the degree of cleanliness maintained. Usually from ten days to two weeks will be sufficient. This statement is predicated on the supposition that the irritation has been eliminated. The condition of the epithelial lining should be tested with the periodontal explorer at each return of the patient. In the beginning the pocket tissue will bleed on the slightest touch; with a good epithelial lining it will not bleed. The reaction of the epithelium may thus be known.

After the pocket has healed, presumably without reattachment of tissue to the cementum, and, therefore, with the bottom of the gingival crevice at the position of the deepest detachment, a readjustment of the tissues of the gingiva will very likely occur; it will become shorter and there will be a slight notch or depression in its crest, corresponding to the position and depth of the detachment. If the cause of irritation has been corrected, the case should require no further treatment. It is as though that particular section of the gingiva had receded to an extent equal to the detachment.

As pockets are deeper, the difficulties of securing a satisfactory epithelial lining are increased, both in the removal of deposits and the maintenance of cleanliness. If the pocket is not very broad, the syringe must be held in exactly the right position and considerable force must be used if it is to be thoroughly cleaned. If the patient is to be entrusted with a share of the care, he must be very carefully trained so that his use of the solution will be effective. If success is to be attained by this method, the pocket must be kept clean. Twice daily irrigation is best and the deeper the pocket, the more important is the frequent cleansing. Casual irrigation, or thorough syringing once a week will not be effective, as cleanliness will not be maintained. Medication is of no advantage, as it is more likely to inhibit rather than promote the epithelial proliferations.

This method should be tried in every case in which it seems at all feasible. If it does not succeed, it should reduce the infection and improve the tone of the tissues, so that they will be in the best possible condition for the alternate method of treatment.

RESECTION OF GUM. If it is the dentist's best judgment that a satisfactory result can not be attained by the above mentioned method, or if it has been tried and a good epithelial lining of the pocket has not been secured, the elimination of the pocket by resection of the gum should be considered. It is necessary to weigh a number of related matters before reaching a decision; these will be discussed later. The principles involved in this operation and the tissue reactions will be presented here. It may be presumed that a pocket is 3 mm. or 4 mm. deep on the buccal surface of a bicuspid. The probability of reattachment of the pocket tissue to the cementum is so slight as to be an impracticable consideration.

The pocket is sufficiently deep that a good epithelial lining cannot be maintained because it cannot be kept free from irritation and infection. If the conditions are such that the pocket can be eliminated by cutting away all of the pocket tissue, this will effectively remove the obstacles to complete healing, and establish conditions which will enable the patient to keep the tissues clean.

Figure 1508 illustrates about the extreme limit of destruction of bone about the lower incisors, in which a gum resection might be indicated, and Figure 1509 the extreme limit of destruction of the interproximal bone in the molar region. In this case the teeth are very firmly held by the remaining bone and the bifurcations are not involved.

The removal of the tissue which forms the pocket, not only eliminates the pocket as a harbor for micro-organisms, but also removes practically all of the infected tissue. Thorough irrigation of the region with salt solution before and after the operation leaves the freshly cut surfaces about the margins of the pocket in excellent condition for prompt healing. In removing the pocket

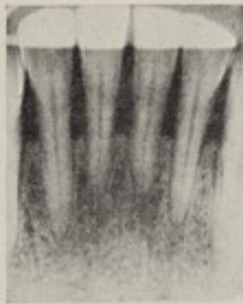


FIG. 1508.



FIG. 1509.

FIGS. 1508 and 1509 illustrate cases showing about the extreme limit of bone resorption in which a gum resection might be employed in treatment.

tissue, the incision is made at approximately a right angle to the surface of the tooth and the epithelium of the gum tissue will immediately grow over this and heal the wound. Within from ten days to two weeks this new epithelium will have become so firm that it may be brushed vigorously with an ordinary tooth brush without discomfort to the patient and without the slightest hemorrhage. The tissues of the region are as secure against reinfection as the other tissues of the mouth, providing the form is such as to prevent no unusual difficulty in maintaining cleanliness.

A further and very desirable reaction occurs after the tissues have fully healed. The epithelium first grows over the cut surface to the line of attachment of the peridental membrane to the cementum. Then, within the next several weeks, the counterpart of a normal gingiva is formed. The epithelium is gradually arched occlusally, apparently by a push of the connective tissues, so that it takes the form of a normal gingiva with an epithelial lined crevice.

Figure 1510 is from a photomicrograph of a labio-lingual section through a portion of the root and labial supporting structures, three months after a gum resection by the author in 1918. The patient was a man about 50 years of age. There were pockets varying from 5mm. to 8 mm. in depth about the lower incisors, and the teeth were so loose that extraction was advised. Upon the patient's insistence, a gum resection was performed, with the understanding that he would consent to the removal of the teeth three months later, if they did not then have considerably less motion. At the end of the agreed time, the teeth had not tightened sufficiently to justify their retention and an incision was made through the gum in such manner that a portion of the labial plate of the bone and soft tissues were removed with the four teeth in one block. In this labio-lingual section, the Figure 1 indicates the



FIG. 1510. Newly formed gingiva following gum resection. See text.

position of the line of the incision in resecting the gum. This was at the deepest part of the pocket. The cementum was notched a little with a chisel at the time. The Figure 2 indicates about the position in which the scalpel entered the gum, so that all of the tissue to the incisal of a line from 1 to 2 was developed from the tissues beneath, after the operation. When the epithelium of the gum had proliferated over the cut surface, it was apparently pushed incisally by the connective tissues below, until it assumed its present form. This new gingiva has a healthy epithelial covering, which is quite as thick in the gingival crevice as in a normal gingiva. Figure 3 marks a deep projection of the epithelium, and 4 the crest of the bone of the process. The outer surface of the bone is undergoing slight resorption, evidently to reduce its thickness near the crest, thus conforming to the contour of the newly developed gingiva.

In resecting the gum, the incision is usually so planned that new tissue will not reform over the dead cementum, other than the new gingiva just mentioned. However, it is possible, in certain cases, to so make the incision that the pocket tissue will be replaced with a new tissue which will have a good and complete epithelial lining. This will be discussed later.

The method of gum resection is not applicable to all pockets which cannot be treated by the elimination of the irritation and cleanliness. There are certain limitations which will be considered later. One of the limitations is that it shall be used only for pockets of moderate depths.

EXTRACTION OF TEETH. When pockets are so deep, or other complications prevail which contraindicate gum resection, and conditions are such that infection of the pocket tissue cannot be prevented, the teeth involved should be extracted, without regard for the fact that they may be serviceable in mastication.

If any additional evidence were desired relative to the part which the cementum plays in maintaining the chronicity of these infections, it is found in observing the prompt healing of the tis-



FIG. 1511A.



FIG. 1511B.

FIG. 1511A. Case in which the only treatment is the extraction of the four lower incisors.

FIG. 1511B. Case in which the first molar should be extracted.

sues when the teeth are removed. The almost immediate obliteration of the infection is definite evidence that the tissues have within themselves the ability to destroy the organisms with which they are invaded, as soon as they are relieved of contact with the cementum.

Figure 1511A illustrates an extreme case of bone resorption in the lower incisor region, in which the four incisors should unquestionably be extracted, while Figure 1511B shows a very extensive destruction of the bone about a lower first molar, including the bone of the bifurcation, which leaves no alternative but to extract the tooth. In this case, there has been much less injury to the bone on either side of the second bicuspid, which suggests the desirability of a gum resection following the extraction of the molar. The pocket on the distal side may be eliminated in the healing of the first molar socket, but that between the bicuspid should have attention and a gum resection would probably be the best treatment.

TREATMENT PLANNING.

The planning of treatment of chronic pericementitis, for cases in which a considerable number of teeth are affected to varying degrees, is indispensable if one is to accomplish the best results. The information recorded on the examination card should be so complete that a careful review of the case may be made in the absence of the patient. It will usually be desirable, both from the viewpoint of the service to be rendered and the management of the patient, that the decision as to treatment be postponed until the second appointment. It is of particular importance in undertaking the treatment of cases of long standing, in which it will be necessary to extract one or more teeth, that the patient's attitude regarding the loss of teeth be known before the patient is told whether or not extractions are to be recommended. Many such patients have avoided the dentist for years in their desire to "save their teeth," or have left the dentist under whose care they have been for the same reason—because he has told them that certain teeth should be extracted. These patients are seeking a dentist who will tell them that he can "save their teeth," yet it is in their own best interest, when mouth conditions so indicate, that they be persuaded to accept the judgment prompted by careful study of the facts. The dentist must not only know that he is right in the treatment which he plans; he must be able to convince the patient.

To express what appears to the patient to be "snap judgment," might incline the patient to go elsewhere. Therefore, unless the patient has in some way expressed his willingness to part with a few teeth, it will usually be best to dismiss him with the statement that some of his teeth are in bad condition, but that it is desirable to review the examination record and lay out a plan of treatment, which will be ready on the patient's return. He leaves with only the suggestion that extractions may be necessary, but is assured of a careful study of his case, and retains a hope that he may not lose his teeth.

Regardless of the patient's attitude, it is usually advantageous to study the examination chart and the radiographs and carefully map out a program which will include whatever replacements may be necessary.

ORDER OF PROCEDURE IN TREATMENT PLANNING.

A definite procedure should be followed in planning the treatment for cases in which many teeth are variously affected. The following order is suggested:

1. The teeth which are missing should be noted in order that their absence will be taken into consideration in planning the reconstruction of the mouth.
2. The teeth which should without question be extracted should be noted as a guide for their removal, also for purposes of planning the reconstruction.

3. The remainder of the denture should be studied to weigh the possibilities of reconstruction. This should include a study of the pulp canals and apical regions as shown by the radiographs, to determine whether any such teeth should be removed, also the contours of the crowns, the occlusion and teeth that have elongated. Several of the teeth are likely to be listed as having moderate to deep pockets and there may be some question as to whether they should be removed or the pockets eliminated by gum resection. The decision should be reached only as a part of an analysis of all conditions which have a bearing on the reconstruction. Such a study will develop reasons why certain of these questionable teeth should be marked for extraction, others for gum resection. This will be referred to in connection with Figures 1513, 1514 and 1515.

4. Other teeth than those that were questionable may have been already listed for gum resection. Following the decision under item 3, the gum resections to be performed should be indicated on the chart.

5. All teeth should be gone over in a search for deposits of calculus.

6. Teeth with shallow pockets should be listed for treatment by eliminating irritation, followed by an intensive program of cleanliness, and inflammations of the gingivæ, which have not yet caused detachments, should receive attention.

7. Whatever may have been planned in the way of replacements should be done at the most appropriate time in relation to the progress of the case.

GUM RESECTION OR EXTRACTION. The records of the examination of the mouths of three persons are illustrated in Figures 1513, 1514 and 1515. These are not records of actual examinations, although closely similar conditions are frequently observed. Especial attention is called to the record on the lower right side on all three charts; they are exactly alike. The third molar is missing, there are pockets varying in depth from 4 mm. to 6 mm. from the distal of the first bicuspid to the distal of the second molar, inclusive. The contacts between the molars and between the second bicuspid-first molar are open, apparently due to the depth of the pockets; the contact between the bicuspid is weak and food has evidently been forced through, injuring the septal tissue. The condition about the molars, particularly, represents about the maximum depth of proximal detachments that might justify a gum resection and a decision should not be reached until a study of the condition of the remaining teeth has been made.

In Figure 1513, it is presumed that the patient, who is 60 years of age, is wearing a full upper denture. If the upper natural teeth were present and in good condition, the same decision would be reached as to the treatment of the lower teeth. The patient's care is marked as being poor; his immunity to caries is high,

as indicated by the fact that there are but three restorations—in the occlusal surfaces of molars; there are deposits of salivary calculus on the lingual surfaces of the incisors; the gingivæ are generally inflamed. The record for the bicuspids and molars on the lower left side shows that the condition of the supporting structures is worse than on the right side. The pockets are deeper, and pus was discovered in the pocket to the mesial of the first molar, which is marked as being loose, and occasionally tender to pressure; the second bicuspid and second molar are slightly loose. In this case there would seem to be no question as to the desirability of extracting the second bicuspid and the molars on both sides and of replacing them with a lingual bar denture.

NAME		RES.	NPIR		ADDRESS	
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BUS.						EXAMING
TEL.						
AGE 60						DATE
						NEXT EXAM
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CRIES: 123 GINGIVÆ: 123		Pus Occasional tenderness				
DI TE WIN GS X - RA YS CA SE HST DRY MOD BLS PHO TO		D C B A B C D NP				DR EV SER VICE ES TI- MA TE
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FIG. 1513. Studies in treatment planning. See description in text.

In Figure 1514 the patient is 58 years of age. The occlusion is recorded as normal, the care of the mouth fair, the susceptibility to caries moderate, and the condition of the gingivæ generally fair. The teeth on the lower left side are in good condition, except for an open contact between the first molar and second bicuspid, with 3 mm. detachments of the septal tissue. This is due to a mesio-occlusal restoration in the first molar which does not make contact with the bicuspid. It can be replaced and thus reestablish the contact. Therefore, so far as the lower arch is concerned, it would seem desirable that a gum resection, instead of extraction, be performed on the right side. However, the record for the upper right bicuspids and molars shows that the first and third molars are missing and the second bicuspid is to be extracted on account of a chronic abscess. In most cases, a bridge might be placed from the second molar to the first bicuspid, but there is a memorandum that the

second molar is tipped mesially and it is slightly loose. The upper anterior teeth are in good condition, as are the left bicuspids and molars. In view of the fact that the upper and lower teeth on the left side and the anterior teeth around to and including the right first bicuspid above and below, all give promise of serving this patient throughout his remaining years, and in consideration of the difficulty of making a satisfactory replacement of the upper right posterior teeth, it seems desirable in this case to extract the lower right second bicuspid and the two molars, instead of resecting the gum. In this case no replacements would be attempted posterior to the first bicuspid, above or below, on the right side.

NAME _____ RES. _____ ADDRESS _____
 NUMBER _____ TEL. _____
 BUS. _____
 TEL. _____

AGE 58

DATE _____ NEXT EXAM _____

RIGHT LEFT

Tipped mesially.

Occlusion N

CARIES 123

GINGIVAE 123

REFERRED BY _____ REPORT TO _____

DI TE WIN QS X - RA YD CA SE HIST GRY MOD ELS PHO TO

PR EV SER VICE ES TI- HA TE

RED ORT PNT ENT ME MO
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FIG. 1514. Studies in treatment planning. See description in text.

In Figure 1515, patient age 52, the conditions on the lower right side are the same as in Figures 1513 and 1514, as previously mentioned. This patient takes good care of his mouth and has enjoyed a high degree of immunity from caries. The lower left second bicuspid is marked as congenitally absent and the occlusion NM-N, indicating only the mesial movement of the lower left molars on account of the absence of the second bicuspid. Deposits of serumal calculus are marked on the lingual enamel of the upper incisors, but there are no pockets. Deposits of salivary calculus are recorded on the lingual surfaces of the lower incisors. The only inflammation of the supporting tissues on the lower left side is due to an open contact between the first and second molars. This can be corrected by placing a mesio-occlusal inlay, with a bicuspid dummy attached, in the first molar, forcing the first molar distally to close and maintain the contact. The bicuspid space is less than normal on account of the mesial position of both of the molars, so

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NM		18		18		18		18	
DIL TE		WIR CS		X -		RA Y3		CA SE	
NM		18		18		18		18	

FIG. 1515. Studies in treatment planning. See description in text.

that a rest on the first bicuspid would not be required. In the upper arch the teeth and supporting structures are in good condition, except for inflammations of the septal gingivæ on either side of the right first molar, due to a mesio-occlusal restoration which does not make contact. Both contacts can be made tight with a new restoration. Therefore, in this case it seems desirable to do a gum resection on the lower right side.

These cases are cited to impress the need for a critical study of all of the conditions in each mouth, which may be helpful in planning the treatment. Many other conditions than those mentioned will often be observed.

ORDER OF PROCEDURE IN TREATMENT.

In the case for which the examination is recorded in Figure 1499, on page 195, the treatment as planned is entered on the same card in Figure 1516. The order of procedure in carrying out the treatment would, as a rule, be as follows:

EXTRACTIONS. The lower left first molar, with the most active infection in the pockets to the mesial and distal, should be extracted first. If there occurs no reaction of consequence, the upper right second bicuspid should be removed three or four days later. In this case the extraction of the lower third molars, about which the investing tissues are not seriously infected, might be delayed for a short time, if there should be any special reason for so doing.

GUM RESECTION. Gum resections are indicated for the labial and proximal surfaces of the six lower anterior teeth, also between the lower right first and second bicuspid. Deposits of salivary calculus had already destroyed the tissues to the lingual

Gallagher, John H. 3765 North main st
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FIG. 1516. Order of procedure in treatment. See description in text.

of the lower incisors. Deposits of both salivary and serumal calculus should be removed from the teeth concerned a few days before the operations of resecting the gum are performed, in order that the inflammation may be reduced as much as possible.

SCALING. The scaling operations may, if convenient, be completed for all of the teeth before undertaking the gum resections, otherwise those teeth about which the gum is not to be cut away may be scaled at a subsequent time. The deposits of serumal calculus may be heavy on many teeth, with little or no deposit on the lower incisors. It may, therefore, be advantageous to first scale only the teeth to be included in the gum resection and postpone attention to the others. It will usually be best to remove at least the heavier deposits at the earliest convenient time, to reduce the inflammation of the soft tissues.

ELIMINATE CAUSES OF GINGIVITIS. The treatment of all remaining inflammations of the gingivæ should next receive attention. In this case, the gingivitis to the lingual of the upper incisors would be relieved by the removal of the deposits within the gingival crevice. Following the extraction of the upper right second bicuspid a bridge is indicated; this is to consist of a mesio-occlusal inlay in the first molar, with a dummy attached, and a rest on the disto-occlusal restoration, previously placed in the first bicuspid. In order to reduce the stress on the upper left cuspid, the buccal cusp of the lower left first bicuspid is to be reduced by grinding. A new mesio-occlusal restoration is to be made for the upper left first molar to reestablish a proper contact with the second bicuspid.

Two bridges are to be made to replace the lower first molars, also to maintain the contacts of the second bicuspids with the first bicuspids. On the lower right the second bicuspid may be first moved mesially by using the extra long bars for the Ferrier separators, as illustrated in Volume II, Figure 504. The types of bridges best adapted to the particular case should be chosen. In this case, a removable bridge, with pin and sleeve attachment to inlays in both abutment teeth, is indicated for the right side, and a removable saddle bridge with clasps and rests for the left side.

The above is not only the order in which the treatment should be planned; it is also the order of procedure in treatment, with the exception that the teeth for which a gum resection is to be performed should be scaled a few days in advance, to reduce the inflammation of the pocket tissue. To best protect the patient's health, the mouth should be cleared of infection at the earliest possible time. This is accomplished by first extracting all teeth marked for that operation, and then eliminating by gum resection all of the remaining pockets which cannot otherwise be kept clean. In this way the infection is brought under control within a reasonably short time. There is another advantage in this plan. It will often be noted that teeth which were slightly loose, approximating those that were extracted, will be much more firm within a few days; also that elimination of infection by gum resection will result in greater stability of the teeth involved. In both cases the fibers of the peridental membrane of adjacent teeth will have been relaxed, and as the inflammation subsides they resume their normal tone and tautness, thus holding the teeth more securely in their sockets.

The removal of deposits of calculus as the next procedure, eliminates the irritation which these cause and permits the operator to proceed with the treatment of remaining shallow pockets and regions of gingivitis without detachments, for many of which restorations in the involved teeth are likely to be required to reestablish proper contacts. In the meantime, prosthetic restorations may be under way. It is obvious that the necessities of the particular case will suggest desirable variations in the reconstruction features of the program. An advance decision regarding all of these matters will usually serve to expedite the treatment.

EXTRACTION OF TEETH.

There are a number of signs and symptoms, any one of which generally indicates that teeth should be extracted. They may be summarized as follows:

1. Infection that can not be promptly brought under control. Active infection is indicated by the presence of pus, tenderness of the teeth to pressure, a leucocytosis, a slight temperature, or the involvement of the cervical glands.

2. Teeth that are too loose to be of real service in mastication, regardless of the absence of any or all of the symptoms listed under item 1.

3. A tooth which has a pocket of such depth on a proximal surface as to make it out of the question to maintain the proximal contact, and the disease within the pocket is causing the destruction of the interproximal gum septum and the peridental attachment of the adjacent tooth. When this condition prevails in several

successive interproximal spaces, satisfactory conditions may be established in a limited number of cases by removing alternate teeth, as will be described later.

4. Teeth which have pockets of such depth on the labial, buccal or lingual surface that they are impractical for gum resection. No limit of depth can be mentioned in millimeters. Pockets of moderate depth on the lingual surfaces of any of the upper teeth and those to the buccal of the lower second and third molars present the most unfavorable prognosis for gum resection. Therefore, pockets in these locations frequently call for the extraction of the teeth.

5. In cases in which deep pockets involve principally one root of a multirooted tooth, it may be practical to amputate the root, instead of extracting the tooth.

6. When pockets involve the bone of the bifurcation between the roots of multirooted teeth, they should usually be extracted. A pair of large right and left curved explorers may be passed between the roots to determine the condition as to detachment of the peridental membrane. Recessions of the supporting structures, which expose much of the cementum of any or all of the teeth, bear no special relation to chronic pericementitis. In cases of extensive recession, the bifurcation between the roots of the lower first molars may be exposed sufficiently to permit a beaver-tailed burnisher to be passed through from buccal to lingual, and the tissues may be in healthy condition, entirely free from inflammation.

MULTIPLE EXTRACTIONS. When many teeth are to be extracted, the danger of a severe systemic reaction from the infection suggests the desirability of limiting the number to be removed at one time. The danger can be further reduced by the thorough irrigation of all pockets with salt solution previous to the operation. It has been the author's rule to limit the number to about four teeth in a bicuspid-molar region, or possibly to the six anterior teeth. One should be guided in considerable measure by the patient's general physical condition.

AMPUTATION OF ROOTS. The lingual root of the upper first molar is often hopelessly involved in disease, when no other root in the mouth has lost its membrane. This root may be cut away from its crown, and the tooth left standing upon the buccal roots. If these are healthy, it may do service for many years. These cases generally do exceptionally well. Records show a number in good condition twelve to fifteen years after the amputation. The pulp of the tooth may be vital, or it may have been destroyed by the extension of the peridental infection to involve the periapical tissues. In any event, the pulp must be removed and a root filling made before the operation. The filling of the lingual canal, in only the crownwise portion, should be made with either gold foil or amalgam, following the packing of a piece of base-plate gutta-

percha slightly deeper in the canal as a base. The amputation is performed by cutting the root away close against the crown of the tooth, aiming to cut it at the bifurcation of the roots, with a slope toward the occlusal, which will clean readily. The space laid open in this way will often so fill up with soft tissue that no pocket will remain. It is usually possible to pass the points of the larger size right and left explorers far enough around the root to determine in advance the exact position of the bifurcation. The metallic filling will be cut through and will be polished with disks as the cut surface of the dentin is made smooth. Figures 1517, 1518 and 1519 were made from a model made fifteen years after the lingual root of an upper first molar was amputated.



FIG. 1517.



FIG. 1518.

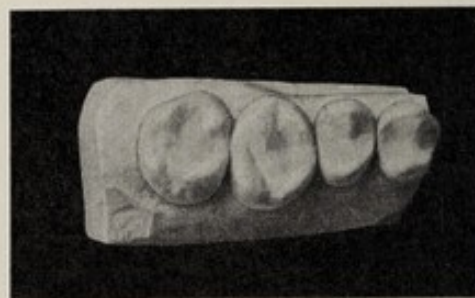


FIG. 1519.

FIGS. 1517, 1518, 1519. Photographic reproductions of plaster model made fifteen years after the lingual root of an upper first molar was amputated.

This operation may be applied to any one root of the upper first molar, and occasionally both buccal roots may be removed, providing the palatal arch is high, so that the lingual root is at only a slight angle to the crown. If the mesio-buccal root has a deep pocket on its mesial surface, it may be generally cut away in the same manner as described for the lingual root. Figure 1520 is a reproduction of a radiograph of an upper first molar, the mesio-buccal root of which was resected close to the crown, instead of being amputated. The radiograph was made nine years after the operation. It appears that the bone had filled in perfectly. The

disto-buccal root of an upper first molar may be amputated, yet it is not quite as easy of approach as either of the other two. It is often much depressed in between the other roots at its junction with the crown, and this makes the operation somewhat more complicated. A close study of the case beforehand will show the direction of the cutting necessary, and it may be accomplished with fissure burs, the ends of which have been ground to a smoothly convex form, insuring that there will be no cutting of other roots by contact of the end of the instrument. Occasionally a similar operation may be done on an upper second molar, although the bifurcation of the roots is seldom low enough, and the roots usually stand too close together to make it successful. In most cases, a radiograph will show the position of the bifurcation and the relation of the roots, or the curved explorers may be passed alongside the root as previously mentioned.



FIG. 1520.



FIG. 1521.



FIG. 1522.

FIG. 1520. Radiograph made nine years after the mesio-buccal root was resected, instead of being amputated.

FIG. 1521. Plaster model of case in which the distal root of a lower first molar had been amputated fifteen years previously.

FIG. 1522. Case in which the mesial root of the lower first molar was amputated.

Either the mesial or distal root of a lower first molar may be similarly cut away, and the tooth will do well with a single root. Sometimes a root of a lower second molar may be removed in the same way. In amputating one root of a lower molar, the corresponding portion of the crown is usually cut away. The cutting to separate the roots should be entirely from the root to be removed, thus leaving the remaining root in the best form to receive a crown. Figure 1521 is from a model of a case in which the distal root of a lower first molar was removed. The entire occlusal surface was restored with a gold crown, which had been in place nearly seven years when the impression was taken. Figure 1522 reproduces a radiograph of a lower first molar, taken five years after the mesial root was amputated. The distal root of this tooth is smaller than the average.

GUM RESECTION.

When pockets are of moderate depth, the operation of choice is the elimination of the pocket by cutting away the tissue which has been detached from the cementum. In general, it may be said that this operation is indicated in all cases in which pockets are too deep to secure and maintain a good epithelial lining, and yet the conditions are not such as to indicate extraction. If there is any question whether the program of cleanliness without gum resection might be successful, it should be tried first; if it fails, the cleansing of the pocket is very excellent preparatory treatment for gum resection. There will more often arise the question of choice between gum resection and extraction, which will usually be settled as a part of the problem of reconstruction.

This operation may be performed in cases in which it is practicable to eliminate the pocket and leave the tissues in such condition that a regrowth will not reform the pocket, also that the region may thereafter be conveniently kept clean by the patient.

Instruments. The instruments necessary for the operation are the following:

- A syringe for injecting procain.
- Pair of peridental explorers to measure the depth of pockets.
- Mouth mirror.
- Two pairs of special knives with heavy blades.
- Pair small surgical scissors.
- Pair of rat-tooth pliers for grasping the excised tissue.
- Two widths of excavating chisels and enamel hatchets.
- Several large sized fissure burs with ends ground to convex form.
- Cotton pliers.
- Cotton on tooth-pick applicators.
- Gauze rolls for packing the mouth.
- Pieces of gauze about one inch wide and three inches long, twisted, to remove debris from interproximal spaces.
- Several strips of sterile wax (2 parts paraffin, 1 part cocoa-butter).
- Rubber bulb syringe.
- Warm salt solution.

The special knives* consist of two pairs, one with blades at about right angles to the handles for reaching far back in the mouth, the other pair at a considerably less angle. The blades are unusually heavy, sharp on both edges and at the points, and will cut through dense bone, when necessary, without injury to the edge of the blade. They are illustrated in Figure 1523. The pair to the left in the illustration will be found satisfactory for practically all cases, although the other pair may be more convenient in the region of the lower second and third molars.

*Designed by Dr. F. W. Merrifield.

STEPS IN THE OPERATION. The steps in the several operations which will be illustrated and described in detail are as follows: (1) infiltration of the region with procain; (2) measurement of depth of pockets and indication of depth on gum as guide for line of incision; (3) the gum tissue should be cut away by a gradually curved incision which will at its deepest point be on a level with the deepest pocket. This cut should be carried through any portions of process which project crownwise of the line of incision; (4) the edge of the bone of the process should be cut away with a chisel or a blunt end fissure bur to a depth of about 2mm. below the line of the previous incision, in order that the remaining edge of bone may be covered and protected by the gum tissue or a blood clot between the gum tissue and the tooth; (5) the field should be irrigated with warm salt water and all granulation tissue and debris should be removed; (6) strips of sterile wax may be used to fill the interproximal spaces and protect exposed root surfaces from thermal shock.

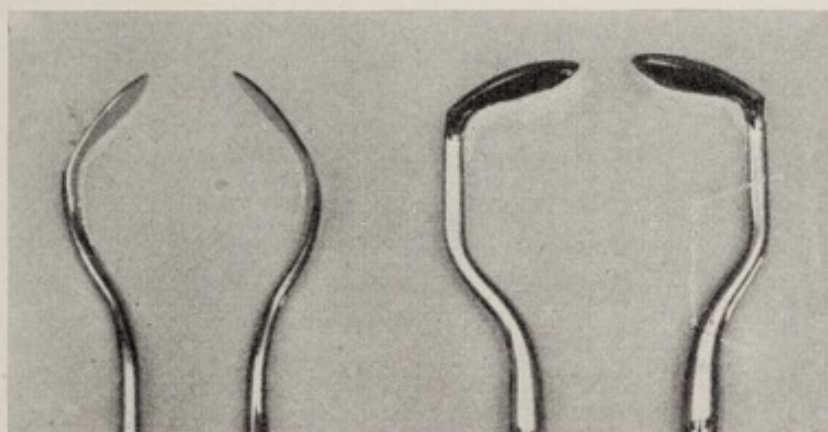


FIG. 1523. Special knives used for gum resections.

LABIAL, BUCCAL AND LINGUAL POCKETS. The elimination of pockets on these surfaces is most satisfactorily accomplished in positions in which the alveolar bone is normally thin, as on the labial surfaces of the upper teeth and on the labial and buccal surfaces of the lower teeth, except the molars. As a rule the bone to the lingual of the upper teeth and to the buccal of the lower molars becomes progressively very much thicker from the crest of the process toward the apex of the root, so that it is not practical to satisfactorily eliminate a pocket of much depth without leaving too broad a shelf of bone. If the palate is high, fairly shallow pockets to the lingual of the upper molars may be so treated. The bone to the lingual of the lower anterior teeth is considerably heavier than that to the labial, yet it becomes thicker rather gradually and pockets of moderate depth may usually be operated with satisfactory results.

The technic of eliminating a single pocket on such a surface, which does not involve the attachment on the proximal surfaces of the root, is illustrated in Figures 1524A and 1524 B. The line of

the incision should be such as to prevent a growth of tissue which would be likely to reform the pocket.

Figure 1524A represents a pocket on the labial surface of a lower left central incisor and it is presumed that the lingual and proximal tissues are in good condition. The line M is the crest of the gingivæ; the line C is the cemental line; the line B represents the crest of the bone of the alveolar process. It will be noticed that a little of the bone to the labial of the left central is missing. A periodontal membrane explorer may be passed into a pocket between the tooth and the gum as far as the indicated destruction of the bone. In this case there are no other pockets.

Figure 1524B illustrates the plan of eliminating such a pocket. The incision should be in somewhat the form of a letter V, making a broad notch in the labial gum, which is less likely to heal over than an incision which only eliminates the pocket. It will be noticed that none of the attachment of the periodontal membrane of the neighboring teeth has been injured, as the incision meets these teeth just at the cemental line. The labial portion only of the inter-

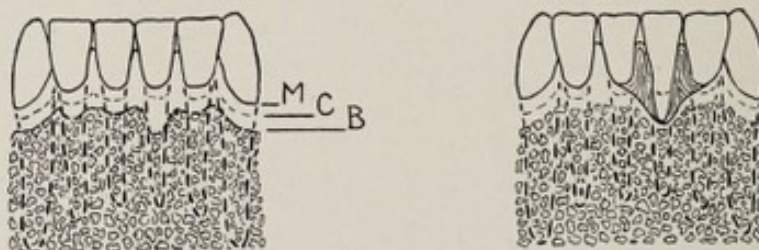


FIG. 1524A. A single pocket on a lower incisor.

FIG. 1524B. Gum tissue cut away to eliminate pocket.

proximal septal tissue is removed on a plane which is inclined incisally from labial to lingual, following the cemental line to its crest on the proximal surfaces of the teeth and cutting away a little from the crests of the septal gingivæ, where they normally approach the points of contact of the teeth.

Figure 1524C represents four pockets on the labial of the lower incisors; there are no proximal pockets. A periodontal membrane explorer may be passed into each of these pockets separately as far as the indicated destruction of the bone. To eliminate these, an incision is made from cuspid to cuspid in the form shown in Figure 1524D. In this case it would be necessary to trim away a little of the labial portion of the interproximal bone, also a very slight portion of the tissue attached to the cementum of each proximal surface from the mesial of one lateral incisor to the mesial of the other lateral incisor.

After the tissue is removed the line of the incision should be followed with the blade of a chisel, the handle of which should be

held as nearly parallel to the long axis of the tooth as may be convenient, to trim away from 1 mm. to 2 mm. of the edge of the bone in any position in which it is exposed, or stands as high as the line of the incision, in order to be certain that the bone will be entirely covered by soft tissue and protected by a blood clot. The field should then be irrigated with warm salt solution and all granulation tissue and debris should be removed. The subsequent treatment should consist of irrigation with salt solution. In these cases the patient can more effectively cleanse the region of the operation by rinsing the mouth thoroughly, than with the rubber bulb syringe.

The same principles apply for the elimination of buccal or lingual pockets. In each case the incision is so planned as to remove as little tissue as is necessary beyond that which forms the actual pockets, to prevent a growth of tissue to reform the pocket. In making the incision, it will often be necessary to cut through portions of the bony process which project crownwise of the line of the incision.



FIG. 1524C. Pockets on the labial surface of the four lower incisors. FIG. 1524D. Gum tissue cut away to eliminate pockets.

FIG. 1524E. Upper incisors, modified gum resection in cases in which it is expected that new tissue will grow to reestablish the pocket, but with a better epithelial lining.

The same procedure may be followed in the upper incisor region although the appearance may contraindicate the operation if the pockets are deep and the teeth show prominently in smiling and talking.

In cases of single deep pockets in positions in which an exposed root surface would be unsightly, as on the labial surface of an upper incisor, only that tissue which forms the pocket may be cut away, with the expectation that it will reform, but that in so doing the newly formed tissue will have an epithelial lining which will be less likely to become infected. See Figure 1524E. In such cases, epithelium quickly covers the cut surface, growing from the gum surface to the cementum along the line of both of the vertical incisions, as well as the horizontal incision in the position of the bottom of the pocket. The wound is thus completely healed within a few days. Then, during the next several weeks, the tissue in the deepest part will build across more and more, gradually reforming the pocket until nearly all of the pocket tissue is replaced. The inner surface of this new tissue will have a good epithelial lining.

A depression will remain at the crest, corresponding to the position of the pocket. Such a pocket is difficult to keep clean and may therefore become reinfected unless the patient takes exceptional care of it.

PROXIMAL POCKETS IN THE INCISOR REGION.

It is rather the rule than the exception, when there are pockets on the labial surface of the lower incisors, that similar pockets will be found on the lingual surfaces, also detachments of about the same or slightly less depth on the proximal surfaces of all four teeth; or the lingual tissues may have been completely destroyed to considerable depth by deposits of salivary calculus. The detachment will usually be a little deeper about the central incisors than the laterals. In each case the incision on either the labial or lingual side should be a continuously curved line, which will include all of

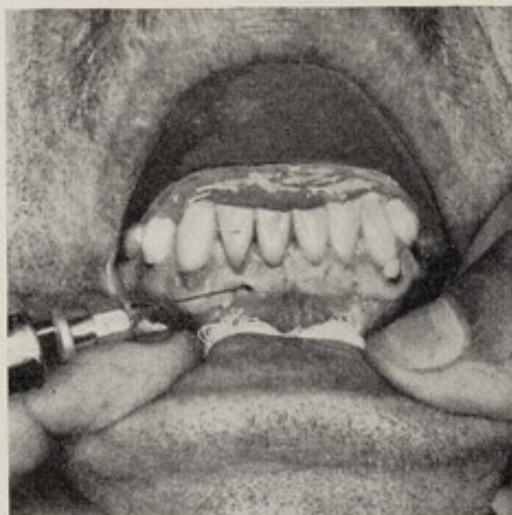


FIG. 1525A.

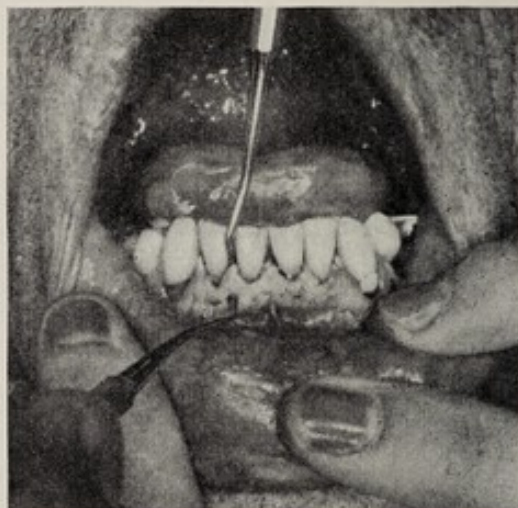


FIG. 1525B.

FIG. 1525A. Anesthesia for gum resection.

FIG. 1525B. Measuring and marking pocket depths.

the detached tissue. If the incision is a little deeper on one side than the other—labial or lingual—the interproximal tissue should be so trimmed away as to connect the two with evenness of contour. If some of the interproximal tissue has been removed, two strips of sterile wax, about the width of a wide polishing strip, should be laid on the lingual and labial surfaces respectively and pressed into the interproximal spaces, so that it fully covers the cementum which has been exposed by the operation. This protects the blood clots in the interproximal spaces and prevents the growth of unhealthy granulation tissue. It also reduces the danger of thermal sensitiveness. The incorporation of any medicament in the wax is likely to delay rather than promote healing. The wax should be left in place for from twenty-four to forty-eight hours.

TECHNIC FOR LABIAL, INTERPROXIMAL AND LINGUAL GUM RESECTION IN THE LOWER INCISOR REGION, RECORDED WITH PHOTOGRAPHS.

In the series of illustrations,* Figures 1525A to 1525H, the various steps in the performance of a gum resection to eliminate pockets ranging from three to four millimeters in depth, about the lower anterior teeth, are clearly shown. These are cases in which the bone has been destroyed fairly evenly about all four incisors, with possibly some destruction of bone about the cuspids as well.

In Figure 1525A, the hypodermic syringe is in place to induce suitable anesthesia. A number of injections are made, usually in positions overlying the interproximal regions of the teeth concerned. Similar injections should be made into the lingual tissues, if they are involved. Anesthesia of the tissues immediately in-

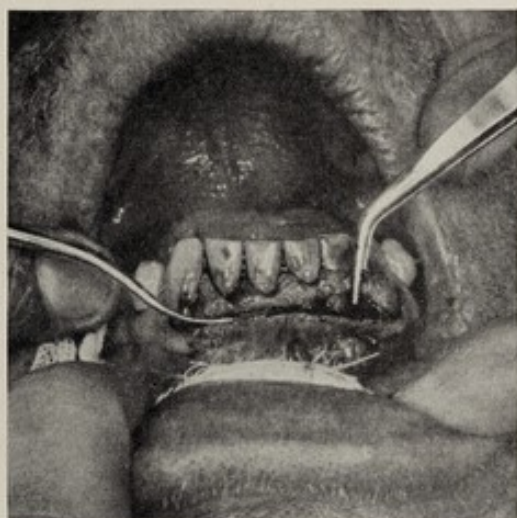


FIG. 1525C.

FIG. 1525c. Initial incision.

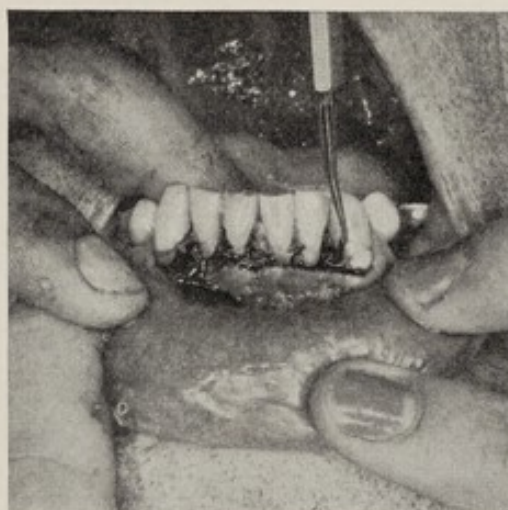


FIG. 1525D.

FIG. 1525d. Clearing interproximal spaces.

involved should last for a longer time than is necessary for the extraction of teeth.

Figure 1525B demonstrates the use of peridental membrane explorers in measuring pocket depths. In this case, one instrument is placed in the pocket to the mesial side of the lower right lateral incisor, to determine its depth. The blade of the explorer is held in a direction parallel with the long axis of the tooth and shows a detachment of 4 mm. The position of the bottom of the pocket is indicated on the labial gum tissue with an explorer held at right angles to the long axis of the tooth. This is done by pressing the end into the epithelium far enough to leave its mark or to cause a very slight hemorrhage, as shown in the illustration. The same instrument with which the pocket is measured is regularly used to also mark the gum. Such markings are made for each labial, lingual

* These and a number of other illustrations in this volume were made with the new Burton clinical camera, designed especially to photograph conditions within the mouth.

and proximal detachment, for the teeth within the operative zone. These markings are not unnecessary traumatizations. When united with a scalpel, they become a part of the line of incision through the soft tissues.

Figure 1525C illustrates the incision. A pair of pliers is used to lift the incised labial tissues as they are progressively separated by the incision. As a rule, particularly if the pockets are of some depth, a first incision should be made directly through the tissues to, and possibly including some of the bone. This should be followed by a second incision, in which the blade is placed in the former cut, and the point is then directed incisally to separate the labial tissues from those within the interproximal space, also to sever any remaining attachments to the roots. The tissues are lifted with the pliers while the second incision is made. If the gum is to be resected on the lingual side at the same time, both

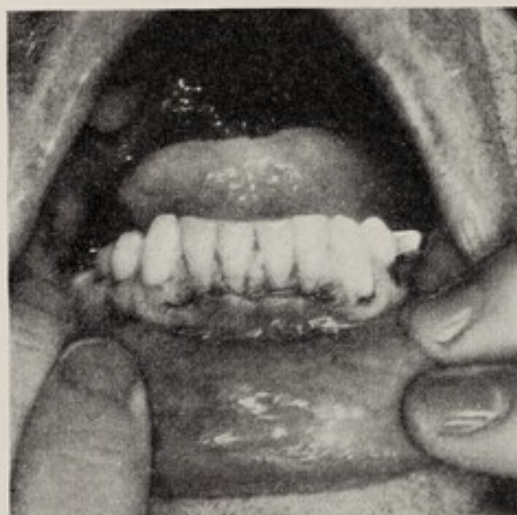


FIG. 1525E.

FIG. 1525E. Zinc chloride packs in interproximal spaces.



FIG. 1525F.

FIG. 1525F. Open interproximal spaces, with organized blood clots.

incisions, labial and lingual, should be made before the tissue is removed.

Figure 1525D shows the case after the labial and lingual tissues have been excised and the septal inflammatory tissue overlying the bone in the interproximal spaces has been removed. The septal spaces are then packed with pieces of gauze, which have been dipped in an 8% solution of zinc chloride, to aid in developing blood clots over the bone. This should be done in each interproximal space from which the septal tissue has been removed, before clearing the next space. In the illustration, all of the interproximal spaces have been packed, except that between the lower left lateral incisor and cuspid. In this space the binangle chisel 12-6-6 is being carried through the interproximal space, while held close against the cuspid, with the cutting edge of the blade in contact with the alveolar bone and the long axis of the instrument nearly parallel

to the long axis of the cuspid. The same instrument should then be held close to the distal surface of the lateral incisor, and carried through the space to remove tissue that may remain attached to it and to the bone to the incisal of the line of the incision.

This instrument should then be used to cut along the labial alveolar crest from the lateral to the cuspid. Thus, the inflammatory tissue is completely separated from the bone in the labial aspect of the septal space. A piece of sterile gauze is then packed tightly into this space to prevent the tissue on the lingual side of the space from slipping through to the labial while the lingual septal gingivæ are removed in a similar manner.

Figure 1525E shows the case with the zinc chloride packs in place. On completing the operation these packs should be removed.

Figure 1525F shows the case after removing zinc chloride packs, with open septal spaces with blood clot organized over the



FIG. 1525G.

FIG. 1525G. Paraffin and cocoa butter packs.

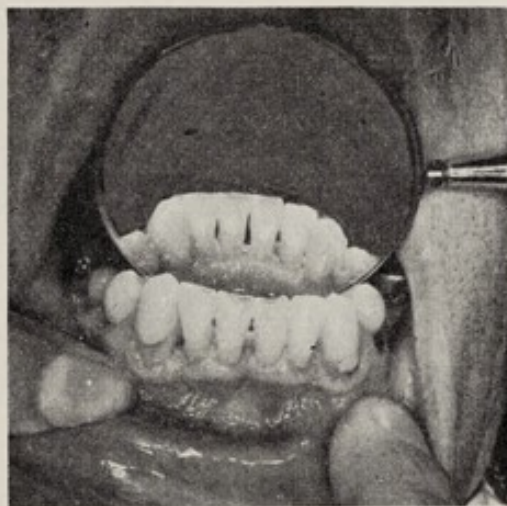


FIG. 1525H.

FIG. 1525H. Case three weeks after gum resection.

interproximal alveolar process. The labial and lingual soft tissues are left a little higher than the cut edge of the bone in order that they may more readily grow over the margins of the bone.

As shown in Figure 1525G, strips of sterile wax, consisting of one volume of cocoa butter to two volumes of paraffin, have been placed in the interseptal spaces, covering the labial (and lingual) cementum of the exposed roots. A narrow strip of the wax, a little longer than the first incision, is laid against the labial surfaces with one edge against the freshly cut surface of the gum, and is then pressed gently into the interproximal spaces. A similar strip is placed on the lingual side. The two strips are joined in each interproximal space, but with pressure so lightly applied that the wax is not pressed against the freshly cut surface, thus allowing space for a suitable blood clot. There should be no interference

with a growth of the muco-periosteum over the bone, as that might cause necrosis of the crest of the bone.

Figure 1525H is from a photograph of this case three weeks after the operation. It shows the perfect healing of the soft tissues over the bone. They are quite free from inflammation.

Figures 1526A, B, C and D illustrate another case in which the same operation was performed, although the pockets were of slightly less depth. The photographs are enlargements from selected frames of a 16 mm. film which shows every detail of the



FIG. 1526A.

FIG. 1526A. Initial incision.

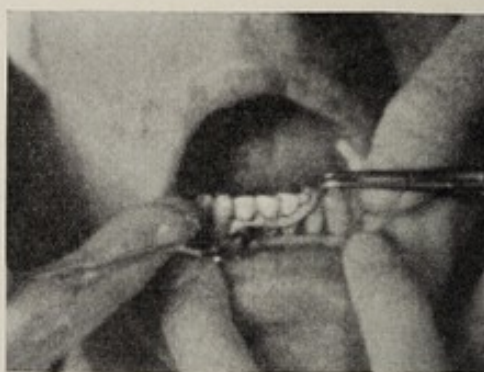


FIG. 1526B.

FIG. 1526B. Removing the resected tissue.

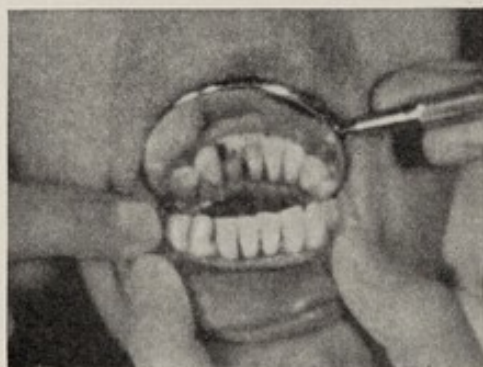


FIG. 1526C.

FIG. 1526C. After the interproximal spaces have been cleared.

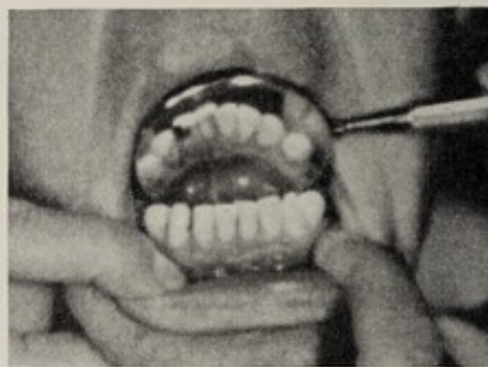


FIG. 1526D.

FIG. 1526D. Paraffin and cocoa butter packs in place.

operation. Figure 1526A illustrates the incision, made after the pocket depths had been measured and marked on the gum. Figure 1526B shows the lifting of the labial strip of gum tissue with a pair of pliers as the incision is made. Figure 1526C illustrates the condition after the interproximal spaces have been cleared. In Figure 1526D the operation has been completed and the wax is in place; the lingual view is fairly well shown in the mirror.

Several other illustrations, made from radiographs and photographs give some additional information as to the condition of the bone before and after gum resection, also the appearance of the soft tissues after healing has taken place.

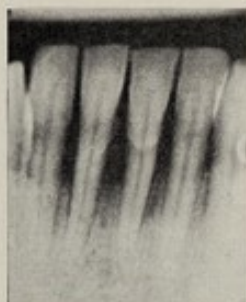


FIG. 1527A.

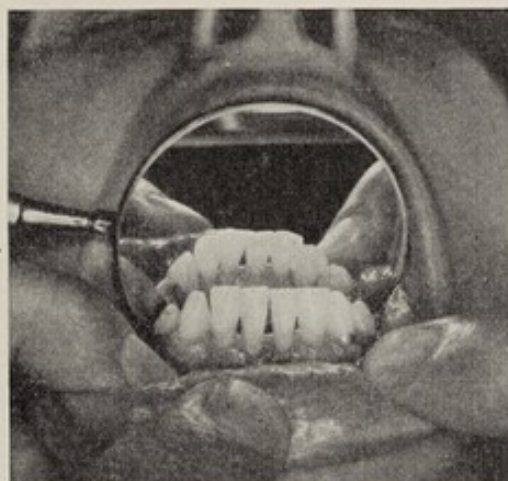


FIG. 1527C.



FIG. 1527B.

FIG. 1527A shows the radiograph just previous to a gum resection and FIG. 1527B, nine months later. FIG. 1527C is from a photograph taken nine months after the gum resection.

Figures 1527A, B and C illustrate the case of a woman of 40 years. The first film was taken previous to the gum resection, the second film and the photograph, Figures 1527B and 1527C were both taken nine months later. The gingivæ are quite free from inflammation, judged from a careful clinical examination.



FIG. 1528A.



FIG. 1528C.



FIG. 1528B.

FIG. 1528A shows the radiograph previous to gum resection and FIG. 1528B ten months later. FIG. 1528C is from a photograph taken ten months after the gum resection.

Figures 1528A, B and C similarly illustrate the case of a woman 45 years of age. Ten months elapsed between the time of the operation and the making of the second film and the photograph, which are shown in Figures 1528B and 1528C.

PROXIMAL POCKETS IN THE BICUSPID-MOLAR REGION. In the elimination of a proximal pocket, it is necessary to cut away the buccal and lingual plates of the alveolar process, opposite the particular interproximal space, so that the highest point of the bone remaining will be midway from buccal to lingual, and the surface of the bone will slope away in both directions, leaving a convex contour where it had been made concave by the infection.

Figure 1529A illustrates a pocket between the lower left second bicuspid and first molar, due to lack of contact of these teeth. It will be noticed that a little of the interproximal bone has been



FIG. 1529A.



FIG. 1529B.



FIG. 1529C.

FIG. 1529A. A proximal pocket with slight resorption of bone between the second bicuspid and first molar. FIG. 1529B is a mesial view showing the resorption of the central portion of the bone, without involvement of the buccal and lingual plates. FIG. 1529C shows the line of the incision.



FIG. 1529D.



FIG. 1529E.



FIG. 1529F.

FIG. 1529D illustrates the use of a chisel and a fissure bur with convex end, for trimming the bone to the buccal and lingual of the interproximal space. FIG. 1529E shows the contour of the interproximal bone after the operation. FIG. 1529F shows the condition after healing.

destroyed. The gum margin is at M, the cemental line at C, and the normal crest of the bone is at B. The periodontal membrane has been detached from the distal surface of the bicuspid, also from the mesial surface of the molar. However, the buccal and lingual plates of bone, opposite this interproximal space are not injured, as shown in Figure 1529B.

Figure 1529C illustrates the lines of incisions on both buccal and lingual to eliminate such a pocket. After the depth of the pocket has been indicated on the surface of the gum, the incision is begun, in this case, at the center of the buccal surface of the first molar and the point of the blade follows a gradual curve to

include the greatest depth of the pocket and return to the crest of the gingiva near the mesial angle of the buccal surface of the second bicuspid. All along, the cut will include the full thickness of the bone and will therefore trim away the crest of the process to about the level of the deepest resorption of bone in the buccolingual center of the process. A similar cut is made on the lingual side and the excised tissue is removed.

In order that the interproximal space may be kept clean after the operation, it is necessary that the highest point of the bone be in the center of the space bucco-lingually, therefore the buccal and lingual portions of the bone must be trimmed. This is done with either chisel or bur without cutting away more of the soft tissue, as illustrated in Figure 1529D. The smooth convex end of the bur is held against the root; this bur should not be passed into the interproximal space as the roots would be damaged if the blades came in contact with them. Figure 1529E shows the contour of the bone with the soft tissue flaps overlapping it. The



FIG. 1529G.



FIG. 1529H.



FIG. 1529I.

FIG. 1529G illustrates a case with several pockets between the bicuspids and molars. FIG. 1529H shows the same case after gum resections. FIG. 1529J illustrates the plan of leaving the surface of the interproximal tissue on an incline from lingual to buccal.

space between the flaps is filled with a blood clot, which serves as a trellis for the gum tissue to build across. Figure 1529F shows the condition after healing.

In many cases, there are several proximal pockets in the bicuspid-molar region, as illustrated in Figure 1529G. The only difference in the operation is that one incision on either side, buccal and lingual, exposes all of the interproximal regions, trimming away sufficient tissue—gingivæ and bone—on the immediate buccal and lingual sides of the teeth to maintain a continuously curved line. The line of the incision and the contour of the interproximal tissues is shown in Figure 1529H.

In some cases, it will be best, particularly in the upper arch, not to cut away the crest of the process to the lingual of the teeth; instead of the interproximal bone being convex from buccal to lingual after the case is healed, it should slant from lingual to buccal as illustrated in Figure 1529J.

PHOTOGRAPHS OF A CASE. Figures 1530A, B and C illustrate a case in which the incision extended from the upper right central incisor to the distal of the second molar. The patient was thirty-five years of age. The photograph which is reproduced in Figure 1530A was made a week after the teeth had been scaled, cleaned and polished, so that the inflammation had been considerably reduced. The better tone of the tissues at the time of operation makes for more effective anesthesia, less pain and prompt healing.

Figure 1530B was taken immediately after the operation. The pockets were for the most part on proximal surfaces and varied from 4mm. to 5mm. in depth. In this case it was necessary to cut away the crest of the process on the labial and buccal surfaces of



FIG. 1530A.



FIG. 1530B.



FIG. 1530C.

FIGS. 1530A, B and C. A case before the operation of gum resection; immediately after the operation; and two weeks later.

all of the teeth involved, in order to place the line of the gum, after operation, at the proper level in relation to the position of the interproximal bone. In operations for the elimination of proximal pockets, it is always necessary to so plan them that, when the case is healed, the interproximal gum tissue will be convex from buccal to lingual or slope from lingual to buccal.

Figure 1530C shows the same case two weeks after the operation. At this time the new epithelial covering was so firm that vigorous brushing with a medium stiff tooth brush caused neither discomfort nor the slightest hemorrhage.



FIG. 1531A.



FIG. 1531B.

FIGS. 1531A and B are reproductions of radiographs made before and six months after a gum resection.

Figure 1531A illustrates the condition of the bone before and Figure 1531B about six months after the operation. There was a shallow pocket between the lower bicuspid and a deeper pocket between the second bicuspid and first molar. The building of subperiosteal bone over the crest of the process between the second bicuspid and first molar indicates the healthy condition of the septal tissue.

POCKETS WHICH ENCIRCLE THE ROOTS. In cases in which there are detachments of about even depth about all or nearly all of the teeth, as occurs in neglected cases in which there may be a deposit of serumal calculus encircling the enamel of practically every tooth, the operation of eliminating the pockets is very simple, as the bone requires very little attention. Deposits of the type referred to are illustrated in Figures 1355, 1356 and 1357. It is only necessary that the blade of the knife be kept against the edge of the bone as it is moved from tooth to tooth, and that all the soft tissue be cut through to the tooth and across each interproximal space.

Some years ago, the author was called to see a case in the school clinic in which it was suggested that all thirty-two teeth should be extracted for a patient, because one could press on the gums on either the buccal or lingual side about practically every tooth and pus would exude from the pockets; there was a very slight recession of the gingivæ. Three unusual conditions about the case were noted: the patient had thirty-two teeth, all of the contacts were apparently tight, none of the teeth were loose. Further investigation showed that there were almost complete rings of serumal calculus about every tooth and the pockets were all from 3mm. to 4mm. deep. The soft tissues were cut away from third molar to third molar above and below. The deposits were all exposed by the operations and the teeth were scaled afterward. The tissues healed promptly. This patient was observed again two years later when he came to have his teeth cleaned and the gums and gingivæ were in splendid condition. He was a man of about 50 years, whose teeth had been worn short and flat. Presumably the pressure of food upon the gingivæ had supplied the irritation which caused the deposits. He had evidently been continuously immune to caries, and had never used a tooth brush.

TEETH STANDING ALONE. Another type of case in which the gum resection may encircle the tooth, is found in the bicuspid-molar region, when the pockets are so deep that the teeth have moved slightly apart and it would be out of the question to maintain contacts, yet the teeth are only very slightly loose. To use two or several inlays soldered together, will generally prove unsatisfactory, because the deep spaces between the teeth will catch food and there is great difficulty in keeping the interproximal tissue free from infection. As an alternative, every other tooth may be extracted, leaving two teeth, each standing alone. In a particular bicuspid-molar region, in which all five teeth were so involved, the first bicuspid and first and third molars should be extracted. The opportunity would then be presented to easily eliminate the pockets about the second bicuspid and second molar. Inlays should be made for these two teeth with a sanitary gold dummy for the first molar and a cuspid facing for the first bicuspid. Many of the seemingly desperate cases, so treated are free from infection and do well for years.

For any of the operations which have been discussed, the mouth should be divided into six regions — the anterior and the bicuspid-molar regions in each jaw, and operations performed at one appointment should be limited to one of these regions.

STUDIES OF THE HISTOLOGICAL CHANGES SUBSEQUENT TO GUM RESECTION.

In the description of Figure 1510, attention was called to the tissue changes which occur subsequent to the operation of gum resection. These changes may be expected when the conditions are within the limits prescribed as indicating that such an operation should be performed. The epithelium from the gum proliferates over the cut surface and forms a line of epithelial attachment to the cementum. Within from ten days to two weeks this epithelium is usually sufficiently thick and compact that the patient may use the tooth brush vigorously without discomfort and without causing the slightest hemorrhage. During the next few months, there occurs an elevation incisally of the epithelium close to the root and the tissues gradually form a more or less perfect replica of a normal gingiva. The connective tissues seem to promote this change, after the epithelium has covered them. They appear to push the epithelium incisally and at the same time carry the outer ends of the alveolar crest group of the principal fibers of the periodontal membrane incisally, thus reproducing the original group of gingival fibers. The height of this new gingiva doubtless depends, in part at least, on the stimulation from mastication, and possibly in part from the vigorous brushing.

The following studies, with patients of varying ages, were made by G. R. Lundquist during the past several years as the opportunities presented. Histological sections of the tissues are

shown to demonstrate the healing and reorganization of the tissues removed at periods of two weeks, one month and three months after the operation of gum resection. The gingivæ which formed in three months should be compared with the study made by the author some eighteen years ago, in which the elapsed time was also three months.



FIG. 1532A.



FIG. 1532B.

FIG. 1532A shows the regeneration of tissue that had taken place within two weeks after eliminating a pocket 4mm. deep. FIG. 1532B is a mesio-distal section through two lower incisors in the same case.



FIG. 1533A.



FIG. 1533B.

FIGS. 1533A and B show a mesio-distal section and a labio-lingual section of the lower anterior teeth one month after gum resection.

Figure 1532A is a labio-lingual section of a lower cuspid, two weeks after the operation, which shows the healing of the tissues that had taken place. The patient was 45 years old. The pocket was 4 mm. deep, therefore this newly forming gingiva is entirely below the cemental line of the tooth. The epithelial covering is heavy and forms a lining for the very slight gingival crevice, which is so slight that it cannot be observed clinically.

Figure 1532B is from the same case as Figure 1532A. This is a mesio-distal section showing the interproximal tissue between the lower left lateral incisor and cuspid. It also illustrates the healing process two weeks after operation. The epithelial covering of the septal gingivæ is very thin and there is some round celled infiltration of the underlying connective tissue.

Figure 1533A is a mesio-distal section of the interproximal tissues between the lower left central, lateral and cuspid. The patient was 40 years old. This case illustrates the healing one month after the operation. By contrast with Figure 1532B, there is a much more substantial epithelium covering the septal gingiva and the round-celled infiltration in the underlying connective tissue is less. The pockets have been eliminated and there is practically no crevice at this time.

Figure 1533B is a labio-lingual section of the same case as Figure 1533A. The epithelial covering of both the labial and lingual gingivæ is about the same as that of the septal gingivæ. During this period of healing, the new epithelium has rapidly increased in thickness. The point of attachment is near the crest of the gingival tissues, and there is little or no crevice.



FIG. 1534A.

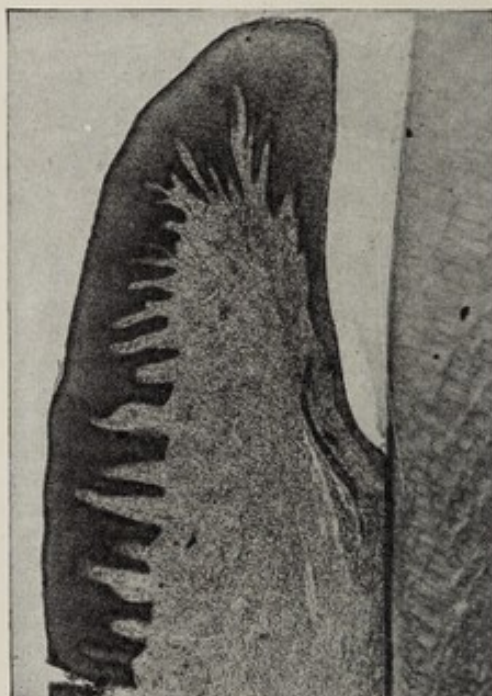


FIG. 1534B.

FIG. 1534A shows the newly formed gingiva, following a gum resection. The photograph was taken three months after the operation. FIG. 1534B is a section of a normal gingiva for comparison.

Figure 1534A is a labio-lingual section of a lower cuspid showing the labial supporting structures. This patient was 48 years old, and the pocket was 5 mm. deep. This case illustrates the healing process three months after the gum was resected. It will be noted that an excellent replica of a normal gingiva has been formed, including the connective tissue projections into the thick epithelial covering, and the reflection of the epithelium into the gingival crevice, which at this time is 1 mm. in depth. A slight epithelial proliferation, attached to the cementum, is noticeable alongside the root of the tooth. The underlying connective tissue is practically free of round celled infiltration. A group of peridental fibers, a replica of the normal gingival group, has grown into the

new gingiva and helps to maintain it in close adaptation to the root, incidentally aiding in the maintenance of the thin edge of the crest. Just below this group, the alveolar crest group is definitely demonstrable.

The normal gingiva, illustrated in Figure 1209, is reproduced in Figure 1534B, in order that the two may be compared. They are so closely similar that the illustration in Figure 1534A might have been substituted for Figure 1209 and described as a normal gingiva, except that the new gingiva in Figure 1534A is adapted to the cementum, while the normal gingiva is adapted to the enamel. There appears to be no reason why this new gingiva should not perform the same function as the normal gingiva in protecting the underlying connective tissue.

PHOTOGRAPHS OF HEALED CASES.

Photographs of three cases are presented herewith. These were taken at periods varying from six months to ten years after the operation. In each of these cases, a second operation was not performed, and the tissues received no special dental care. The patients were carefully directed as to the home care, in some cases in the matter of brushing, in others in the use of the syringe for twice daily irrigation.

Figure 1535A is a reproduction of a photograph taken six months after an operation in the upper incisor region. This diabetic patient was 22 years old at the time, and the gums were resected about all of the teeth, upper and lower, in six separate operations. The operation on the lower incisors is illustrated in Figures 1526A, B, C and D.

With the metabolic disturbance characterizing diabetes, there was a hypertrophic gingivitis, which had progressed to the point where pus was being continuously discharged from the progressively developing pockets. This condition existed in spite of restorations to reestablish contacts, and frequent appointments for the removal of deposits and the cleaning of the teeth. After consulting with the patient's physician, it was decided to operate. The physician had administered insulin at regular intervals, and the case has been kept under control with the gums in good condition over a period of six years.

Figure 1535B illustrates the condition of the gingivæ about the upper incisors two years after a gum resection was performed to eliminate pockets of from 4 to 5 mm. in depth. This patient was 40 years old at the time of the operation and has received none other than the periodic care which is given to all cases in the matter of watchfulness for deposits and cleanliness. The home care by the patient has been excellent.

Figure 1535C is a case showing the condition of the gingivæ about the lower incisors and cuspids ten years after a gum resection was performed to eliminate pockets of from 4 to 6 mm. in

depth. The contour of the gingival tissue shows a rather even convexity in the interproximal spaces and they hug the roots of the teeth, as the gingivæ formerly hugged the gingival portion of the crowns of the teeth.

This patient has been very faithful in the cleaning of this region. He was instructed to use the method of brushing suggested by Charters, illustrated in Volume III, Figures 628 and 629, by which the bristles are pressed into the interproximal spaces to clean the proximal surfaces of the teeth and the surface of the septal gingivæ. The method generally used in brushing the labial and lingual surfaces would leave the more important septal tissues uncleaned and therefore subject to irritation and possible re-infection.



FIG. 1535A.



FIG. 1535B.

FIG. 1535A illustrates the condition of the tissues six months after a gum resection.

FIG. 1535B shows a case two years after gum resection.



FIG. 1535C.

FIG. 1535C shows a case ten years after gum resection.

During the past twenty-five years this operation, requiring a very simple technic, has been used routinely in the treatment of selected cases by a group of dentists who have made a special study of the treatment of chronic pericementitis. As it has been gradually refined in its minor details it has come to be used by an ever increasing number of practitioners. Much of the evidence, including many of the illustrations, has not been published previously. The statement now seems to be justified that the several plans of treatment recommended, based on knowledge of the probable tissue

reactions in each case, are likely to produce satisfactory results. Some experience, coupled with careful observation, will make possible a rather accurate prognosis in each case.

SPLINTS FOR LOOSE TEETH. In some cases splints of various forms may be used to prevent tooth movement. If there is a single pocket which has progressed sufficiently to cause the contact to be opened, a splint may be applied to hold the two teeth firmly together and thus prevent food impaction through the contact, and also prevent the opening of other contacts. Two gold bands, soldered together, may be cemented on. Such an appliance is particularly well adapted to lower incisors. In the bicuspid and molar region, two gold inlays, soldered together at the position of the normal contact of the teeth, may be employed. Or, in the case of the upper incisors, an appliance may be placed on the lingual surfaces, if the bite will permit.

Figure 1536 is from a radiograph taken on the occasion of the first examination of a man sixty years of age. He stated that the platinum appliance, placed to stabilize the lower central incisors had been placed nine or ten years previously. Deposits of serumal calculus are shown, attached to the mesial surfaces of both centrals.



FIG. 1536 shows a stay appliance on the lower central incisors.

The radiograph reproduced in Figure 1412 illustrates a case in which a pocket about three millimeters deep on the mesial surface of an upper left central incisor, had caused the teeth to separate about one millimeter. This was the only pocket in the mouth and the investing tissues were otherwise healthy. The teeth were moved into contact and an inlay was made for a lingual cavity in this tooth, while a single hole was cut in the right central, and a piece of iridio-platinum wire, bent to fit in this hole, was soldered to the inlay. The pocket received careful attention and the depth had increased very little in the five years which elapsed before this radiograph was made.

Such measures may be indicated in some cases, but contraindicated in others where the pockets are no deeper. The greater the number of pockets, the less should one think of stay appliances, and the more of extraction. The difficulties and dangers increase with the number and depth of the pockets. In those cases in which there is a more or less general involvement of the investing tissues, the value of the teeth for mastication must be weighed against the danger to the general health, and radical treatment should be favored.

REMOVAL OF DEPOSITS AND CARE BY THE DENTIST.

The removal of deposits of serumal calculus, which have occurred either upon the enamel of the gingival crevices or upon the cementum within the pocket, is of much importance in the treatment of chronic pericementitis. As has been said, a considerable number of cases present in which no deposits have occurred over long periods of time. However, the rule is that deposits do occur, although there is the widest possible variation as to the rapidity of their accumulation, depending in part on the extent of the inflammatory reaction.

The thorough removal of the deposits requires the most painstaking technic and the limit of persistence. If many teeth are involved, attention should be given to a particular section of the mouth or to a few teeth at a sitting, in the effort to remove every particle of deposit. This should be done in a systematic way, to include every denuded surface. In cases in which gum resections are to be performed, the teeth should be scaled and the pockets thoroughly irrigated with salt solution, preferably several days in advance of the operation. The inflammation will thus be materially reduced.

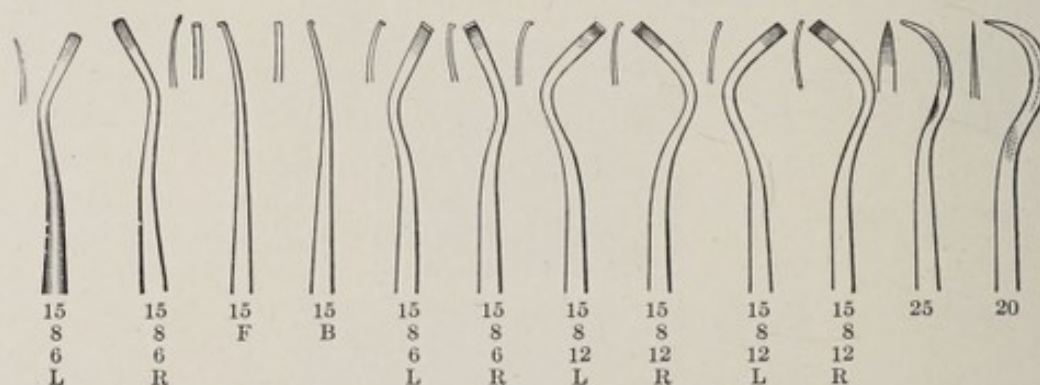


FIG. 1537. Set of scalers for removing deposits of serumal calculus.

INSTRUMENTS. The technic of removal is practically the same as that already mentioned for the removal of deposits from the enamel within the gingival crevices, except that as pockets are deeper, the difficulties in manipulation are increased. The instruments to be used are the same. The set of scalers shown in Figure 1537 was designed primarily for the purpose of reaching the various surfaces of roots in doing this operating.

The accompanying radiographs show several of these instruments in their proper positions. With all of the instruments it will be noticed that the working points—the blades—are practically in line with the handle, the same as the excavators used for cavity preparation. This is an essential feature to accurate manipulation. The greatest length of blade is 8 millimeters; this is considered about the limit of depth of pocket in which this plan of treatment should be employed. Certainly in most cases pockets of considerably less depth will be kept under control with much difficulty, and many teeth with pockets less than 8 mm. deep should be extracted.

There are in this set twelve instruments. Two of these are peridental membrane explorers. They are especially designed for feeling the line of attachment of the peridental membrane to the cementum. These have smoothly rounded ends, so that they will not injure the tissue, and may be carried around each root with the end following the line of attachment of the tissue. The rougher deposits may be easily detected with these instruments, although sharp blades should be used to determine the exact condition as to finer deposits. In making mouth examinations, the explorers are used to determine the depth of pockets. One may have this pair of explorers graduated in millimeters, if desired, for very exact measurements. The use of these explorers is illustrated in Figures 1202, 1203 and 1204.

There are six pull scalers, in three pairs, each having blades 1.5 mm. wide and 8 mm. long, but of different angles. These are all made with curved blades, somewhat similar to spoons, but with square ends. The blades of one pair are straight, as viewed from

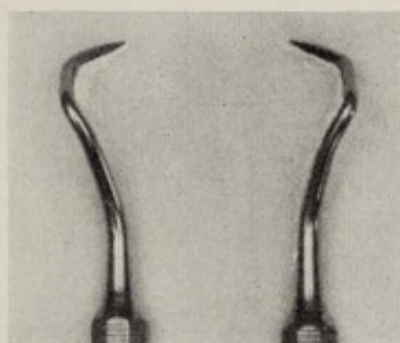


FIG. 1538 shows a pair of triple angle scalers designed to reach both the mesial and distal surfaces of bicuspid and molars. *Lundquist.*

one direction, but have a very slight curve as viewed from the other direction. One has the cutting edge *looking toward* the handle, the other *looking away from* the handle. The second pair has the formula 15-8-6, and the third pair 15-8-12; these having blades at angles of 6 and 12 centigrades, respectively, to the handles. There is one pair of push scalers with the formula 15-8-12. In addition there is a sickle form and a cleoid form, designed to reach shallow depths on the proximal surfaces of front teeth. More recently, a pair of right and left instruments, with triple angle shanks and blades with two edges, have been added to this set. They were designed by G. R. Lundquist to reach particularly the mesial and distal surfaces of the roots of the lower bicuspid and molars. See Figure 1538.

INSTRUMENTATION. The pull scaler, with a slightly curved blade which looks toward the handle, may be conveniently used in almost any position in which the handle can be held approximately parallel with the long axis of the tooth. It is illustrated in Figures 1539A, 1539B and 1539C. It was designed primarily for the incisor

teeth, upper and lower, yet may often be used for the upper bicus-pids and molars, and less often for the lower bicus-pids. It is used to best advantage for labial, buccal and lingual surfaces, yet it may frequently be used for mesial and distal surfaces. It will generally reach the disto-buccal and disto-lingual angles of bicus-pids and molars and, with a buccal approach, distal surfaces may be reached.

The other scaler with a slightly curved blade, looking away from the handle, is illustrated in Figure 1539D. It was designed to reach particularly the mesio-lingual angle of the lower bicus-pids and molars and may be used in the same position for the corresponding upper teeth.



FIG. 1539A.



FIG. 1539B.

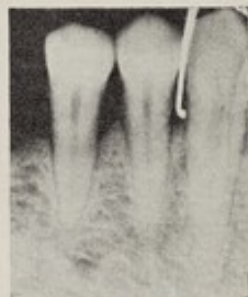


FIG. 1539C.



FIG. 1539D.

FIGS. 1539A, B and C illustrates several positions for the slightly curved pull scaler, which has the blade turned toward the handle.

FIG. 1539D shows the position of the corresponding instrument with the blade turned away from the handle.



FIG. 1540A.



FIG. 1540B.

FIGS. 1540A and B illustrate the use of the pull scalers with blades at 6 centigrade angle.

The pair of pull scalers, with the blade at an angle of six centi-grades to the handle, may be used in almost every position mentioned for the instruments having slightly curved blades. They are generally more convenient for the lower anterior teeth and the upper bicus-pids and molars. One of these blades is shown in position on the lingual surface of a lower incisor in Figure 1540A and on the buccal surface of an upper bicuspid in Figure 1540B. If one of this pair of instruments is convenient to use on the lingual side of a tooth, the other will usually be suitable for the buccal or labial side of the same tooth.

The third pair of pull scalers has the blade at an angle of twelve centigrades with the handle; these instruments were de-

signed for the molar teeth and especially the lower molars. Figure 1540C shows one of these instruments in position on the buccal (or lingual) surface of an upper molar, and Figure 1540D shows it in a similar position for a lower molar. These instruments are oftentimes the most convenient for the lingual surfaces of the lower incisors, particularly in cases in which these teeth are inclined lingually and one must view the field of operation in a mouth mirror.

The pair of push scalers, the blades of which are at an angle of twelve centigrades, were designed to reach the proximal surfaces of the teeth, in positions in which there is insufficient space for the pull scalers described above. In Figure 1540E, one of these instruments is shown on the buccal side of a lower bicuspid as it is

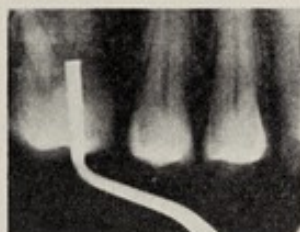


FIG. 1540C.



FIG. 1540D.

FIGS. 1540C and D illustrate the corresponding instruments with blades at 12 centigrade angle.



FIG. 1540E.



FIG. 1540F.

FIG. 1540E shows a 12 angle push scaler about to be placed in the interproximal space. FIG. 1540F shows one of the triple angle scalers in the interproximal space.

being passed into the interproximal space. It will be rotated slightly to bring the blade parallel to the distal surface.

The sickle scaler is used most frequently for the proximal surfaces of the anterior teeth, and the cleoid form in cases in which there are heavy deposits between these teeth.

One of the pair of new triple angle scalers is being placed in position between the lower bicuspid, in Figure 1540F. The upper surface of the blade is flat and converges to a point. Both sides of the flattened surface are sharp, so that it may be used to scale the distal surface of the first bicuspid, also the mesial surface of the second bicuspid. The interproximal spaces between all of the bicuspid and molars may be reached with this pair of instruments.

FINGER SKILL VERY ESSENTIAL. This set of scalers is considered sufficient in number and variety of form to reach all posi-

tions in pockets about teeth which are not so deeply involved as to require extracting. In fact a smaller number will be sufficient for the most operators. The essential thing for the thorough scaling of roots is the development of proper finger skill. One must be able by the sense of touch to find each particle of deposit, and to so locate it that the instrument may be properly placed for its removal. This is a skill acquired by long training, much the same as the training required to master the finer technic of the piano.

One will do well to occasionally test his ability in this operating, by performing the most thorough possible scaling of a root which is to be extracted, going over the denuded surface again and again, until every particle of deposit is apparently removed. An examination of the root after the tooth is extracted will reveal the thoroughness or lack of thoroughness of the technic employed, and will indicate the measure of success which is being attained in similar operations on teeth which are retained.

SCALERS MUST BE SHARP. It is absolutely essential that scalers be sharp if the deposits are to be successfully removed. The deposits are usually very closely adherent to the cementum and it requires both a very sharp blade and considerable force, accurately applied, to remove them. Isolated nodules may generally be removed with less difficulty than the flatter scale-like deposits. In cases of long standing almost the entire cementum of the pocket may be covered, and the deposit may be in the form of a solid mass, more or less roughened. The removal of such a deposit is much more difficult than of the separate nodules. This requires the most careful technic and persistence and the employment of the sharpest possible blades. These instruments must be delicate and of such form that they may be manipulated within the pocket, without unnecessary injury to the soft tissues. The blades should be sharpened often, but should not require more than a movement or two on the oil-stone with light pressure. The blades of the pull scalers, particularly, may be worn away in a short time by too much grinding on the stone; they must be frequently replaced by new instruments.

As a rule, the pull scalers will cause less injury to the soft tissues than the push scalers, especially by other than the most skillful operators. The pull scalers may be very carefully carried to the depth of the pocket, the edge of the blade being held against the surface of the root, in order to feel the deposit as the blade passes over it, until the movement is stopped by the end of the instrument coming in contact with the attachment of the membrane. Then the blade should be held hard against the root and drawn out in an effort to bring the deposit with it. These instruments are used as hoes. If the instrument does not bring the deposit away, the failure is usually due either to the fact that the blade is not sharp, or that it was not held in proper relation to the root, or the force applied was insufficient.

In the use of the push scalers, the edge of the blade is placed on the enamel near the cemental line, and the instrument, while held close against the root, is carried toward or to the full depth of the pocket, the attempt being made to cut the deposit away from the root with the movement. The finger position should be such that the pushing movement is under complete control by a rest of fingers on neighboring teeth, or possibly by a finger of the opposite hand, to prevent the instrument from plunging into the soft tissue as the deposit breaks away, or if the instrument should slip. In positions in which there is good access and opportunity for perfect control, these instruments are more effective than the pull scalers. The angle of bevel of the blades is such that they will hold their edge better, and remain sharp longer.

LEAVE ROOTS SMOOTH. The effort should be to remove all of the deposit and leave the surface of the root as smooth as possible. Some writers have contended that a portion of the cementum should be planed off in the effort to remove all of it that had become contaminated with the products of the suppurative process, with the idea of gaining reattachment of the peridental membrane to the root. There are several reasons why this seems to be both impracticable and undesirable. Attention has already been called to the fact that the only attachment that might occur would be the same as in cases of planted teeth, involving the resorption of the root. The cementum of the gingival half of the root is usually very thin, and it requires only a few strokes with a sharp instrument to cut through it and expose the dentin in its most sensitive region.

In many cases the cementum of a pocket is considerably softened by the growth of acid forming micro-organisms within the pocket. The acid dissolves the calcium salts from the cementum, softening it in the same manner in which dentin is softened by caries. Cementum in this condition is very easily removed with a sharp instrument.

PAIN IN SCALING OPERATIONS. Pain in connection with scaling operations is caused in some cases by the sensitiveness of the pulp of the tooth and in some on account of the inflammation of the peridental membrane. There is no physiological provision for the transmission of sensation through the cementum. The ends of the dentinal fibrils, just beneath the cementum, must receive some stimulation for sensation to be conducted through to the pulp. Thermal changes may be sufficient to cause pain in cases where the recession of the gum has exposed the cementum, or in the irrigation of pockets with water which is too hot or too cold. Usually pain caused by instruments in scaling is the result of the removal of the cementum, exposing the surface of the dentin, or by injury to the soft tissues, or by pressure on the root while the peridental membrane is inflamed. The area of dentin immediately below the cementum is more sensitive than that closer in toward

the pulp, because of the branching of the ends of the tubules, which present many fine sensitive filaments.

CARE OF TISSUES BY THE DENTIST. Following the removal of the deposits, the pockets should be thoroughly irrigated with warm salt solution, to remove small particles of deposits which may not have been brought away with the scalers. This will also cleanse the space of blood and other debris, and leave the tissue in the best possible condition.

The patient should be required to return several times, if necessary, at intervals of a few days for irrigation of the pockets. This should be continued until the inflammation is reduced and the mouth and teeth are comfortable. The patient's attention should be called to the technic of using the syringe and he should

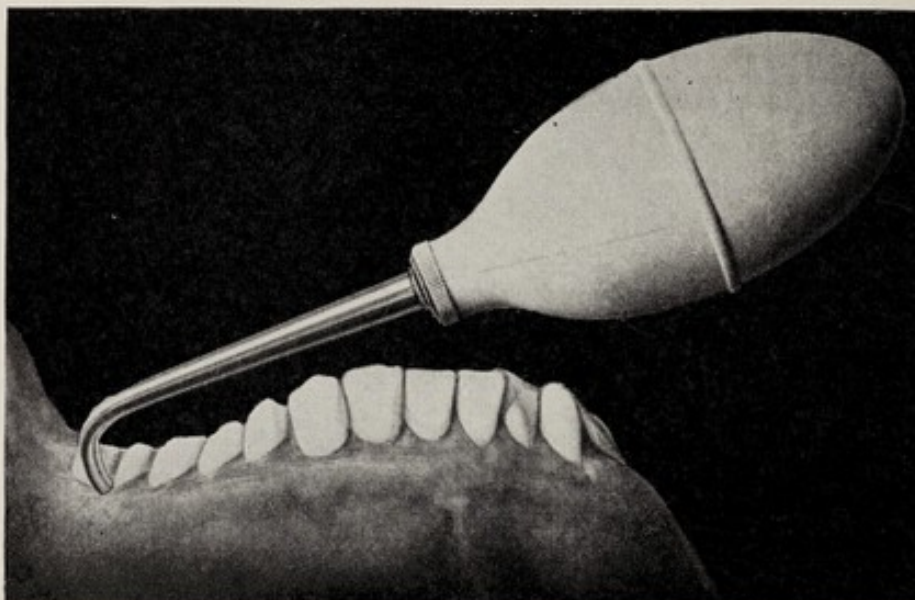


FIG. 1541. The position of the rubber bulb syringe in washing the gingival crevices. The end of the nozzle should touch the enamel of the tooth near the crest of the gingivæ as it is passed along the arch, the angle being such that the water or solution will be forced into the gingival crevices.

come to feel the washing of the pockets in order that he may know that he is succeeding in the subsequent care of his mouth.

CARE BY THE PATIENT. One could hardly conceive of better care on the part of the patient than the washing of such pockets twice daily, using salt solution in a rubber bulb syringe. This is effective in that the space is thoroughly cleaned without injury to the soft tissue. The future of every case in which there has been detachment of the periodontal membrane depends very largely on the care which the patient may be induced to exercise. Those who are faithful may so fully control conditions that little progress, if any, will be made in many years. For all practical considerations, such cases are well so long as they are kept clean. Careful and persistent washing will keep the tissues free from irritation. Under this treatment the progress of such cases may be stayed, and the teeth may be retained for many years of comfortable service, with-

out danger to the general health. Proper care by the patient can not be expected unless the need of it is explained and the patient's interest is awakened. Exact directions should be given, and it should be urged that these be carried out to the most minute detail.

The syringe shown in Figure 1541 is the best type for the patient. The bulb fits well in the hand. If the patient is instructed to hold the nozzle between the thumb and first finger while the bulb is pressed with the other fingers, he will have better control of the position of the end of the nozzle. The patient must learn to hold it in just the right relation to the teeth and the gingivæ. The syringe is about two-thirds of the actual size in the illustration.

In cases in which there are rather wide open interseptal spaces, due to gum resections, with good contacts of the teeth, some food will enter these spaces from the buccal or lingual side. It is not packed in, as occurs when a contact is open, and can generally be removed by thorough rinsing of the mouth. If this is found to be ineffective, the syringe should be used. However, gum resections should generally leave the tissues in such form that cleanliness can be maintained by the thorough rinsing of the mouth.

In the mouths of many elderly persons, the septal gingivæ have receded so far as to expose considerable portions of the roots, and the spaces between the teeth will be filled with food from the embrasures, when there is no leak between the contact points. If the remaining septal tissue is convex from buccal to lingual, the treatment by rinsing should be sufficient, otherwise a syringe should be used. If there are depressions in the septal tissues, they may be made convex by trimming the buccal, and sometimes also the lingual crests of the bone a little.

GINGIVITIS AND SHALLOW POCKETS.

As a part of the scaling operations, the deposits on teeth having shallow pockets, also deposits on the enamel where there are no pockets, should be removed, and these regions should be included in the program of cleanliness. At the same time, attention should be given to the correction of the causes of inflammations of the gingivæ. The methods have already been sufficiently described.

RECONSTRUCTION.

Finally the program of reconstruction, as laid out in the beginning, is to be completed by replacements of certain teeth that were missing at the time of the examination and others recently extracted. It will depend upon the positions of the extracted teeth and the nature of the replacements, whether this work should be undertaken at the earliest possible time, or delayed until the mouth as a whole is in the best condition. As a rule, unless certain teeth need to be replaced because the vacancies show conspicuously, the reconstruction should be delayed until gum resections and the scaling operations are completed.

Diseases of the Soft Tissues of the Mouth

BIBLIOGRAPHY DISEASES SOFT TISSUES PAGE 265

19 ILLUSTRATIONS: FIGURES 1542-1550

THIS chapter includes a brief statement of the etiology, diagnosis and treatment of those diseases which involve only the soft tissues of the mouth and others which occur locally in the mouth and elsewhere. There are several regarding which patients might consult the dentist, although the dentist would be inclined to refer them elsewhere for treatment; others may be treated by the dentist. A few call for minor surgical operations, which the general practitioner might prefer to do, or they may be referred to an oral surgeon. They are discussed here in order that the dentist may have convenient opportunity to become more familiar with them and thus broaden his field of service.

Single illustrations accompany the majority of the descriptions. Most of these were selected from the books and papers listed in Volume I, page 79. All of the diseases selected for this chapter are also included in the chapter on Oral Diagnosis and Volume I, in the section devoted to the Surgical Disorders of the Mouth, page 89, or that on the Diseases of the Soft Tissues of the Mouth, page 108. References to additional illustrations are listed in connection with the diagnostic data presented in Volume I.

ACUTE ULCEROUS GINGIVITIS. VINCENT'S STOMATITIS. Trench Mouth. See Figure 1542. This is an infectious disease usually beginning at the crest of the gingivæ about a few teeth, and may extend to involve the gingivæ about many or all of the teeth, and occasionally the mucous membrane lining the lips and cheeks and the floor of the mouth. The gum about a partially erupted tooth is also a frequent source of the initial infection. It is a peculiarity of this disease that it frequently attacks the gingivæ in a new location about the time when a previous lesion shows signs of improvement. It is characterized by a grayish-white membrane covering a necrotic lesion which is painful and tender and bleeds easily. In the more severe cases it is accompanied by severe salivation, a distinctively fetid breath, extreme tenderness which interferes with mastication and a typical mental depression. The membrane may easily be wiped off, leaving a raw, tender, bleeding surface, which is rapidly covered with a new membrane, and the margins of the interproximal gingivæ early assume an eroded appearance, due to the necrosis of the tissue.

The local cause is infection with the *B. fusiformis* and Vincent's spirochete, and these organisms are usually found in large numbers in the lesions. The clinical symptoms of the disease are more significant than the bacteriological findings, because these

organisms are frequently present in normal mouths, and may be found in pyorrhea pockets and in non specific gingivitis. Smears from the surface of an active lesion may be negative, especially if local therapeutic treatment has been given. The organisms can always be discovered by a careful search, yet too much reliance should not be placed on the microscopic study.

Acute ulcerous gingivitis was first described by Gilmer in 1906. The following statements are selected from his original description: "The onset of the disease is sudden, the earliest symptoms consist of slight malaise which is quickly followed by rapid ulceration, at first confined to the gingivæ, usually about two or three of the anterior teeth; later it is extended to the gums about a number of the teeth, or groups of teeth, but rarely if ever does it include the entire gum margin. The lingual margins and festoons of the gums do not participate at first in the inflammatory processes, but later the festoons are destroyed and deep pockets are formed in the interproximal spaces. Still later the lingual gingivæ



FIG. 1542. Acute ulcerous gingivitis.

participate, but ulcerous manifestations very rarely occur in this locality. In twenty-four hours after the patient's attention has been called to the condition of his gums, the parts attacked present the appearance of having been gnawed away until most of the gum tissue overlying the alveolar process immediately adjoining the teeth has been destroyed. The part of the gum attacked has soft, thickened, and in some instances everted margins. The eroded parts form pockets which are filled in with a grayish pasty mass, similar to those found in syphilitic ulcers in the mouth." Tunnicliff was associated with Dr. Gilmer in the bacteriological studies of this condition.

The disease was widely prevalent among the soldiers of the World War and came to be known as Trench Mouth. It has been similarly observed in the United States Navy.

The disease is transmitted by direct contact and by towels, dishes, glasses, etc., and special precautions should be taken to prevent transmission. It frequently becomes epidemic in a region,

especially in schools, camps, and boarding houses, and appears to vary in virulence from year to year and between different regions. It does not occur in edentulous mouths, and young adults and children appear more susceptible. It may occur in clean mouths, but unkempt mouths offer more favorable conditions for its rapid development. It is generally believed that certain predisposing causes such as diet deficiency, metabolic disturbances and possibly smoking, are important factors in susceptibility, although the infection may occur in any mouth, especially in virulent epidemics.

Differential diagnosis is particularly important since these organisms are frequently found secondary to certain mouth diseases, and their presence clouds the diagnostic signs. This is especially true in diseases where the early symptoms resemble those of acute ulcerous gingivitis, such as diseases of the blood forming organs, and in certain dermatological diseases. In these diseases the mouth becomes more susceptible to infections, and the bacteriological report may lead to an erroneous diagnosis. Differential blood count should be made in all cases of doubt, especially if local therapeutic treatment does not bring a prompt recovery.

Only rarely may the secondary lesions of syphilis, and stomatitis due to mineral poisons, be confused with acute ulcerous gingivitis.

The more immediate causes may be listed as follows: 1. Any source of irritation within the mouth, such as broken crowns of teeth, roots, rough edges of cavities, ill fitting crowns, open contacts between the teeth, partially erupted teeth, etc.; 2. Neglect of mouth hygiene, resulting in accumulation of salivary and serous calculus as well as food debris; 3. Luetic cases where mercury and bismuth are being excreted into the mouth (Such cases may be materially benefited by reducing the dose of mercury or bismuth); 4. Blood deficiencies such as leukemia and anemia, particularly the former; 5. Illness of any character where debilitation is present, resulting in lessened resistance to bacterial invasion.

TREATMENT. Nearly every writer on the subject has developed a particular treatment which he prefers. As a result there is no standardization in the therapeutic approach. Gilmer recommended the use of three per cent hydrogen peroxide (pyrozone) as an antiseptic wash and many writers throughout the years have reported best results with this oxidizing agent. Gilmer found also that frequent and thorough cleansing is an essential measure. Black, G.V., also placed marked emphasis on the necessity for repeated cleansing. Other oxidizing agents found to be of value are potassium permanganate, sodium perborate, chromic acid, and potassium chlorate.

The dyes have also been extensively used—acriflavine, mercurochrome, gentian violet, methylene blue, and others.

Zinc chloride, zinc sulphate, silver nitrate, and copper sulphate are also recommended. As a mollifying agent, Gilmer recommended

the application of compound tincture of benzoin or dilute tincture of iodine applied subsequent to the pyrozone.

Arsenic has been widely used in the treatment, though it is very probable that it has no specific effect upon the local lesions. This metal has been used as Fowler's solution (liquor potassii arsenitis), arsphenamin and neoarsphenamin, and has been employed locally and generally. Potts, H. A., believes that arsenical therapy in this disease is of no special value. Hatton finds the use of arsenic intravenously in the treatment of acute ulcerous gingivitis "a prolonged way of getting the arsenic to the mouth in a dilute form." He holds that "the arsenic is needed only in the mouth and in as concentrated form as is possible."

From this maze of therapeutic agents a simple yet effective treatment may be abstracted and this in a general way is the course suggested by Gilmer. The mouth should be thoroughly irrigated with 3 per cent hydrogen peroxide, one-half strength, or with physiological salt solution. A syringe with a large nozzle, see Figure 1345, should be used, in order that the stream may be of sufficient strength to thoroughly cleanse the inflamed tissues. This should be repeated again and again at each appointment. Hydrogen peroxide may then be generously applied with a cotton applicator. In order to render the painful area more comfortable, a solution of compound tincture of benzoin, 10 per cent, may be used. Such a routine should be carried out once a day for two or three days, after which visits every other day will usually suffice. The teeth should be carefully scaled at the earliest time that this can be done without causing additional injury or too much pain. In view of the tendency of this infection to involve new regions as others improve, those regions not involved when the patient first presents should be scaled and otherwise relieved of every possible source of irritation, in order to limit it as closely as possible to the tissues originally attacked. The scaling should be accomplished with the utmost care to avoid further toxic absorption through traumatized blood vessels. However, it should be remembered that the maintenance of the cleanest possible mouth, free from every form of irritation, is an essential factor in the treatment.

The patient should be instructed to rinse the mouth from three or four times to a dozen times daily with half strength hydrogen peroxide; the number of times depending upon the severity of the case.

Systemic treatment other than to avoid intestinal congestion is ordinarily not necessary.

This simple treatment should bring relief from the acute manifestations in from one to two weeks. After the case is apparently well, bi-monthly examinations should be continued for a time to check against a recurrence. It is notable that patients having had this infection once may show a tendency toward recurrence. Recurrence may be based on infected tonsils and this possibility should always be investigated.

VINCENT'S ANGINA. ULCERO-MEMBRANOUS ANGINA. The name Vincent's angina should be limited to the tonsil and throat form of the fuso-spirillar infection. The lesion is similar to that found in the gingival region except that the ulceration is apt to be deeper and direct diagnosis is the same. This form of Vincent's disease is frequently confused with primary and secondary syphilis and diphtheria and laboratory examinations are usually required to make the differentiation in doubtful cases. If diphtheria bacilli are recovered on blood serum cultures either diphtheria or a mixed infection is indicated. Due to the resemblance between the germs of syphilis and Vincent's disease, it may be necessary to resort to regional lymph node puncture to aspirate fluid for dark field examination. The absence of spirochetes in this aspirated fluid favors the diagnosis of Vincents' angina. The Wassermann test is not reliable at this stage of syphilis.

TREATMENT. The treatment should be much the same as for acute ulcerous gingivitis. It is more difficult to thoroughly clean the mouth on account of the sensitiveness of the gums. All irritations within the mouth should be remedied at the earliest possible time. Laxatives should be given, and the diet should include an abundance of fresh fruits and green vegetables.

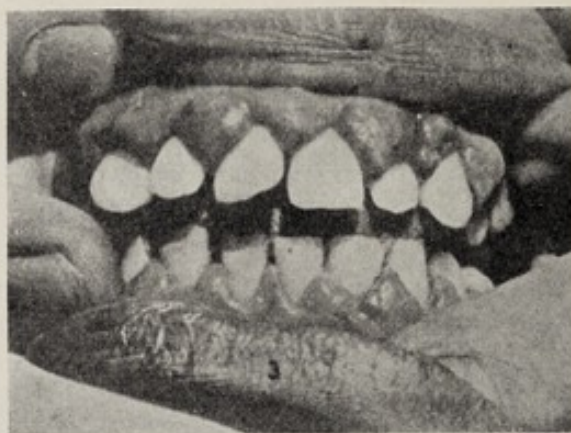


FIG. 1543. Hypertrophic gingivitis. *Prinz and Greenbaum.*

HYPERTROPHIC GINGIVITIS. See Figure 1543. A chronic inflammation with proliferation of the gum tissue by an increase in the size and number of the cellular elements. The gums may in some cases almost completely envelop the crowns of the teeth. This condition develops very gradually, and is usually due to some mild local irritation, of which the patient is usually unaware. In the mouth of an adult, it may be an ill-fitting denture, and particularly one that does not fit the tissues snugly. There may be some discomfort in mastication, particularly in cases in which the teeth are overgrown by the gums, and food comes into pressure contact with the hypertrophied tissues. Seldom is there complaint of pain. The generalized hypertrophy is seldom seen except in children, and often takes on a fibrous character. These cases may be due to faulty nutrition.

TREATMENT. The treatment consists in the surgical removal of the hypertrophied tissue. In some cases, one may be justified in trimming the gums to their normal contour. Buchner* treated two cases by this method and studied the excised tissues histologically. Since there was no recurrence within the next year, this seems to justify the more conservative treatment before adopting radical procedures. However, when the growth is excessive it will usually be necessary to remove the teeth and trim the alveolar process. This should be done in several operations, as the hemorrhage is usually severe.

APHTHOUS STOMATITIS. CANKER SORE. This lesion is characterized by the sudden appearance of single or several shallow erosions or ulcers of pin-head size or larger, very sensitive to irritation, sharply outlined with an intense red margin, while the floor of the ulcer is at times covered with a yellow or gray layer. They are most frequently located in the muco-buccal fold, but may occur almost anywhere on the mucous membrane of the mouth. They are apt to be recurrent. The solitary form is more common in adults, and the multiple variety in children, especially during



FIG. 1544. Aphthous stomatitis. Canker sore. Hayes.

the eruption period of the teeth. Diagnosis is not difficult. See Figure 1544, which shows an ulcer in the muco-labial fold opposite the right lateral incisor.

A rare form of this condition, known as Mikulicz aphthae, is recurrent over a few weeks and persists for possibly ten years or more in the mouths of adults, particularly women.

TREATMENT. The most certain and satisfactory treatment is to touch the center of the inflamed region with a silver nitrate crystal, held in a pair of pliers. If the area is large, the crystal should be applied gently in several places. The tissue will immediately turn white. This treatment is painful for the moment, but no further attention will be necessary. The patient will soon be free from discomfort.

* Buchner, H. J. Thesis submitted in partial fulfillment of requirement for Master's Degree, Northwestern University Dental School, 1932.

DECUBITAL OR PRESSURE ULCERS AND NEUROTROPHIC ULCERS. Two other forms of ulcer, which occasionally occur in the mouth, may be confused with the above; decubital or pressure ulcers and neurotrophic ulcers. The former are always associated with pressure of a tooth or denture and are essentially like the so-called bed sores; neurotrophic ulcers are likely to be related to loss of nerve function, as in palsy or paralysis.

TREATMENT. The treatment of pressure ulcers is to eliminate the cause by trimming the denture, or relieving other forms of irritation. In cases of neuropathic ulcers all forms of irritation, as with the tooth brush, should be avoided.

HERPES SIMPLEX. HERPES LABIALIS. COLD SORE. FEVER SORE. See Figure 1545. This lesion pursues a characteristic course, beginning as numerous small vesicles more or less confluent, self-limited, and rapidly passing through this stage to form slight crusts, with some times an intermediate shallow ulcer stage. The lesions



FIG. 1545. Herpes labialis. Cold sores. Fever sores. *Fordyce.*

may become secondarily infected and resemble impetigo, or a primary or secondary syphilis. Impetigo is associated with characteristic lesions elsewhere on the face, while syphilis begins as a papule rather than a vesicle, lasts longer and may be differentiated by the various methods of demonstrating the *Treponema pallida*. In the mouths of adults, herpes may be confused with aphthae. However, the aphthae are usually solitary and the herpes ulcers multiple. The differentiation between herpes zoster, which is confined to one side of the mouth and herpes simplex may be difficult. The diagnostic signs of herpes zoster are given in the section on mouth manifestations of skin diseases.

TREATMENT. Eruptions of this type within the oral cavity may be treated with a mild mouth wash. The use of a cold cream or other soothing preparation on the lips will lessen the discomfort caused by these lesions.

THRUSH is caused by a yeast-like fungus in the mouths of children and decrepit adults; it is more common in the warm months of the year. It may be first observed on the dorsum of the tongue. It may then involve the palate, the cheeks and the lips. There may be a sweetish, acid odor. The lesions are small, sometimes confluent and are covered by a flat, round white coating which can be readily removed in the early stages and the smears made from it show characteristic spores and numerous interlacing threads, thereby supplying dependable information for diagnostic purposes.

TREATMENT. The best remedy consists of a freshly prepared (not more than a few days old) one per cent aqueous solution of gentian violet, applied with a swab to all parts of the mucous membrane of the mouth to remove all adherent mucus. This treatment should be repeated twice daily for three successive days, then every other day for three weeks. (After Prinz and Greenbaum, who advise against the use of boric acid solutions, which have been commonly recommended in the past).



FIG. 1546A.

FIG. 1546A. Leukoplakia of cheek. *Hayes.*



FIG. 1546B.

FIG. 1546B. Lichen ruber planus of cheek. *Hayes.*

LEUKOPLAKIA. SMOKERS' PATCHES. See Figure 1546A. This is a very common painless lesion occurring in the mouths of persons past mid-life, which may involve, in order of frequency, the tongue, the lining of the cheeks, just back of the angles of the mouth, the lips, the palate and the gums. The large majority of cases occur in the mouths of men who use tobacco excessively in any form. In pipe smokers the palate is frequently involved with a keratotic white area. Leukoplakia seldom occurs in the mouths of negroes. Long continued or frequently repeated irritation of the mucous membrane, such as the biting of the cheeks, the contact of a sharp edge of a tooth with the cheek, or the pressure of any form of artificial appliance may cause this condition. The surface (of the mucous membrane) becomes pale, cloudy and slightly elevated. By degrees

the tissue becomes thicker, more compact, the surface smoother and changes to gray, then becomes white and finally to the appearance of mother of pearl. There may be raised areas of thicker, keratinized epithelium. The forms are greatly varied but as a rule are sharply outlined; the lesions may be solitary, multiple or confluent and vary greatly in size and extent. There may be a feeling of stiffness of these regions, with a sense of dryness and pain on contact with hot or spicy foods.

The differential diagnosis of leukoplakia and lichen ruber planus may be difficult. The color of the two lesions may be the same. Lichen planus occurs more frequently in women, there are usually a number of small lesions arranged in a net-like pattern, and corresponding lesions are usually found upon the skin. See Figure 1546B. Leukoplakia occurs infrequently in the mouths of women, the outline of the lesion is irregular and the patches are likely to be larger and solidly white, or composed of white regions of varying size.

A precancerous change is indicated when a surface which has long been smooth becomes thicker and there occurs papillary growths, accompanied by induration. Secondary and tertiary lesions of syphilis may also be confused with leukoplakia.

TREATMENT. In all cases in which a local irritation, such as the occasional biting of the cheeks exists, it should be corrected. When the upper and lower bicuspid and molars are not in the proper bucco-lingual relation, the cheeks are likely to be caught between the teeth. The buccal cusps of the lower teeth may sometimes be so ground that they will not meet the buccal marginal ridges of the upper teeth as the mouth is closed. In one case, a woman fifty years of age, in which there was a very marked leukoplakia on both cheeks corresponding to the line of the occlusion, due to an almost end to end bite of the buccal surfaces, the author built out the buccal surfaces of the upper molars on both sides of the arch. An occlusal restoration was removed from each tooth and, after extending the cavities through to the buccal along the line of the buccal groove, inlays were cast which overlapped the buccal surfaces and served to push the cheeks away as the upper and lower teeth came into contact. A year later the leukoplakia had entirely disappeared.

Other treatment should consist of the elimination of possible causative agents, such as the use of tobacco. The possibility of a cancerous change should be sufficient to justify the complete discontinuance of the use of tobacco in any form. There appears to be no justification for the use of medicaments of any kind. The value of radium or Roentgen rays is questionable. If a precancerous change occurs, an oral surgeon should be consulted, as the safest plan may be to remove the tissue involved. This may be done with the knife, by electric coagulation or the actual cautery.

MERCURIAL STOMATITIS. See Figure 1547. The ingestion of mercury by persons exposed to it in their occupations, or who are receiving mercurial injections, may lead to a severe attack of ulcerative stomatitis, particularly in mouths that are not kept clean, or in which inflammations previously existed. The stomatitis may be preceded by a dark coloration due to the formation of sulfids in the mucous membrane. There may be a peculiar metallic taste; the tissues become swollen and congested; they are tender to the touch and bleed readily. This condition is likely to involve the gums most prominently. The initial inflammation may be in any position of irritation, such as the inner surface of the cheeks along the line of occlusion of the teeth. It may spread to include the tongue and palate. The tongue may become swollen and ulcerated, particularly along the edges which are in contact with the teeth. There may be profuse salivation and foul odor. As the peridental tissues become more and more involved, the teeth become loose and their



FIG. 1547. Mercurial stomatitis. *Hayes.*

movements cause pain. The cervical glands may be enlarged. These symptoms, with the history of the absorption or ingestion of mercury, suffice to make a diagnosis.

TREATMENT. All occupational contact with mercury should be stopped, and it should be completely discontinued as a therapeutic agent. Sodium thiosulphate, administered intravenously, is used for the elimination of mercury. The mouth should be kept clean and free from irritation. The mouth should be thoroughly rinsed with salt solution morning and night and after each meal. In preparation for courses of treatment with such drugs as mercury and bismuth, the mouths of patients should be thoroughly cleaned and every form of irritation of the gingivæ should be eliminated. Such a plan will prevent a stomatitis in the majority of cases; at least it will diminish the severity of the attack. In general it will greatly enhance the effectiveness of the treatment by physicians.

BISMUTH STOMATITIS. The lesions caused by bismuth are similar to those resulting from mercurial poisoning, but are much

less severe. There may be a bluish or purple line along the margins of the gingivæ and in positions in which the gums may have been previously inflamed.

TREATMENT. The treatment is practically the same as for mercurial stomatitis.

LEAD STOMATITIS. This is an occupational disease among persons who handle lead. It may also occur in persons who use cosmetics containing lead. As with mercury and bismuth, existing inflammation, due to lack of cleanliness or irritation, seems to be a necessary forerunner to this form of stomatitis. The gum margins, especially the papillae between the teeth, are most frequently involved. The inflammatory changes are slight, but the pigmentation

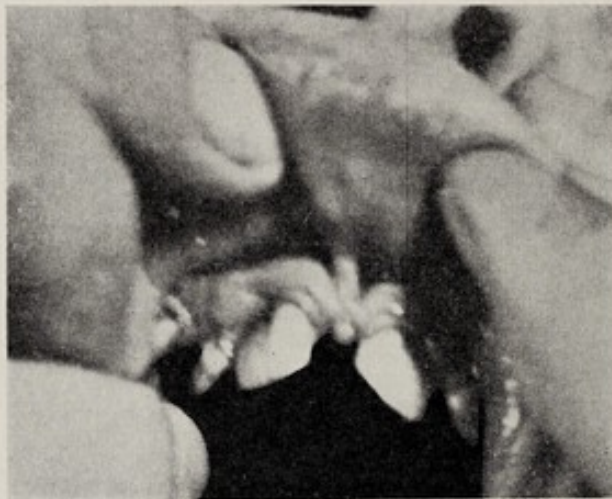


FIG. 1548A. Abnormal labial frenum. *Hayes.*

is darker—producing a bluish black gum margin, the so-called “lead line.” The patient may notice a sweetish taste in the mouth, and may have attacks of colic, also wrist drop and foot drop. The history of the patient’s occupation, or the use of materials containing lead should support the clinical diagnosis.

TREATMENT. Patients exhibiting symptoms of lead poisoning should be referred to their physician. The dentist’s duty is to keep the soft tissues of the mouth free from irritation.

X-RAY BURNS. The radiations from the X-ray tube, radium and similar radio active substances may cause lesions of the gums and mouth mucous membranes that are not at all characteristic, resembling in some cases a low grade stomatitis or burn and in others an ulcerative condition comparable to acute ulcerous gingivitis. A correct diagnosis can be reached only by a process of elimination, plus a history of exposure to such agents. With respect to effects of the radio active substances there are often changes in the bone marrow and the bone forming organs for which search should be made.

TREATMENT. There appears to be no satisfactory treatment for X-ray burns. The general statement may be made, however, that the burns resulting from mild exposure over a period of years, which occurs with X-ray operators, is generally most persistent. A single exposure, which may cause considerable inflammation soon after the exposure, usually does no permanent damage.

ABNORMAL SUPERIOR LABIAL FRENUM. See Figure 1548A. This frenum is often unusually large and may extend between the central incisors, with some fibers attached to the alveolar process on the lingual side of the arch. It may contribute to the maintenance of a diastema between these teeth.

TREATMENT. That portion of the frenum which extends through the interproximal tissue should be removed by making a "V" shaped incision from labial to lingual. This should be done under procain anesthesia.



FIG. 1548B.

FIG. 1548B. Geographic tongue. *Fordyce.*



FIG. 1548C.

FIG. 1548C. Black tongue. *Fordyce.*

GEOGRAPHIC TONGUE. Wandering rash. See Figure 1548B. An intensely chronic circumscribed, more or less circinate desquamation of the surface of the tongue. It is an infrequent disease of early infancy and childhood, but may persist for many years. The surface of the tongue is marked by clearly defined, shiny and smooth, irregular spots or circles which are slightly depressed below the level of the usually fur-covered surrounding structure. The size of the spot varies greatly; in the beginning a spot may be as large as a pea, but gradually widens into a circle and often meets another circle, with which it may intersect. These irregular map-like spots develop, giving rise to the name geographic tongue. The rash may disappear rather suddenly and, after protracted intervals, re-

appear as suddenly as it disappeared. Its reappearance may be due to nervousness or excitement. (After Prinz and Greenbaum.)

TREATMENT. This condition causes no symptoms of consequence and no treatment is indicated.

BLACK TONGUE. See Figure 1548C. The presence of a blackish-brown to yellow-brown, thick, soft, fur-like patch or patches on the dorsum of the tongue, often modified by a slightly bluish or more often a greenish tint, which are composed of the elongated, densely matted hair-like filaments of the hypertrophied filiform papillae, constitutes the clinical picture of black tongue. (After Prinz and Greenbaum.)

TREATMENT. There is no advantage in the treatment of this condition, other than to remove the black spot from the tongue. The discolored filaments may in some cases be bleached with peroxide of hydrogen.

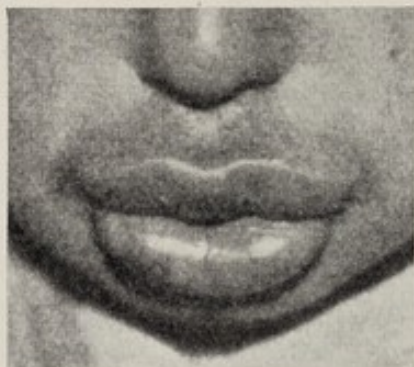


FIG. 1549A.



FIG. 1549B.

FIG. 1549A. *Machrocheilia. Lymphangiectasis. Prinz and Greenbaum.*

FIG. 1549B. *Perlèche cheilitis. Prinz and Greenbaum.*

BURNING TONGUE. This is a rather rare condition in which the patient will complain of an annoying burning sensation in some particular region of the tongue. Some patients state that the burning sensation is severe, yet careful examination reveals no abnormal condition of the tongue to account for the disorder. There may be great mental distress owing to the fear of impending malignancy. The complaint may be of constant pain or of occasional recurrences. It occurs more frequently in women, who may be anemic or neurotic.

TREATMENT. As a rule, these cases require no treatment. When the patient is considerably alarmed, in spite of assurances that the condition is harmless, Dean has cocainized Meckel's ganglion, with satisfactory results. (After Prinz and Greenbaum).

MACROGLOSSIA. LYMPHANGIOMA. This is a condition in which the tongue is enlarged as a result of the dilatation of the lymph spaces beneath the epithelium. They may contain clear fluid, or it

may be hemorrhagic, due to the rupture of capillaries, and may be scattered or in patches, which cover a considerable area. These spaces may gradually enlarge and cause the surface epithelium to be thinned. Large cysts may be formed by the fusion of spaces. Occasionally the entire tongue is involved. The condition may be congenital or may result from injury. The enlargement of the tongue, which is very slow, gradually impairs speech and causes difficulty in eating. When the tongue becomes excessively large, especially during the period of bone growth, the teeth become displaced and the palate and jaws are deformed. (After Blair and Ivy.)

TREATMENT. The treatment is surgical, either by a wedge-shaped incision to reduce the size of the tongue; or, if the entire tongue is involved, a total excision should be made, for the condition is progressive and will continue to grow unless removed.



FIG. 1549C.



FIG. 1549D.

FIG. 1549C and D. Case of cheilitis exfoliativa, before and after x-ray treatment. Prinz and Greenbaum.

MACROCHEILIA. LYMPHANGIECTASIS. See Figure 1549A. A hyperplasia of either lip, and occasionally of both lips, involving principally the lymph vessels. The blood vessels may also be abnormally developed. The lip may be two or three times its normal size and so everted as to cause a very objectional deformity. The condition is painless.

TREATMENT. The treatment of this condition is surgical and involves the removal of a lengthwise mid-section of the lip, such as will reduce the lip to normal size.

PERLÈCHE CHEILITIS. See Figure 1549B. A regional streptococcus infection, primarily affecting the labial commissures, usually bilateral, in older children of unclean habits and, at times, in adults. Clinically the simultaneous appearance of the disease in several members of the same family testifies to its infectious nature. A mild epidemic has been observed in schools. It is usually limited to the angles of the mouth, although it may extend far toward the

center of the lips. The epithelium assumes a white, mother of pearl tinge; later it becomes macerated, thickened and changes from its white color to a brownish hue. There is a sensation of dryness, which results in the almost constant licking of the lips. The name is derived from *pour lecher*—to lick all around. (After Prinz and Greenbaum.)

TREATMENT. The daily application of Talbot's glycerine iodine solution is recommended to prevent the angles of the lips from becoming dry. All eating utensils, towels, etc., should be sterilized. (Prinz and Greenbaum.)

CHEILITIS EXFOLIATIVA. See Figures 1549 C and D. A persistent exfoliation of the vermillion border of the lips; a rare disease primarily observed during the period of adolescence. It usually begins with a slight redness and scaling of the lower lip, which gradually extends and involves both lips. In well marked cases the lips are covered by adherent, scaly crusts. The removal of the crusts exposes a sensitive reddened derma, which bleeds readily and is often fissured. There may be slight swelling. The symptoms are those of tension, discomfort, sometimes burning or itching and actual pain. (After Prinz and Greenbaum.)



FIG. 1550A. Mucous cyst of lip. Fordyce.

TREATMENT. The constant use of cold cream to keep the tissues soft is beneficial. The condition is inclined to recur.

MUCOUS CYSTS may occur anywhere on the mucous membrane of the mouth. See Figure 1550A. They appear as small, globular, usually freely movable, faintly bluish elevations, and are filled with a thick fluid, which will be discharged if the thin outer wall is punctured. They are formed by the blocking of the openings of the mucous glands and are usually due to trauma. They occasionally reach considerable size, possibly as large as an English walnut. They are painless, except where irritated by trauma or infection.

TREATMENT. The cyst should be excised under procain anesthesia and the cyst wall should be enucleated.

ANGIOMA. See Figure 1550B. These consist of painless, bluish red, soft elevations, occurring upon the lips, cheeks and tongue, which disappear on compression and reappear when released. They may be caused by trauma. For a more complete description of hemangiomas and lymphangiomas, see Angiomas, under Tumors of the Mouth. See also Angiomas, Volume I, page 105.

TREATMENT. The small angioma consisting of a few dilated vessels, requires no treatment. Cases in which the tongue is more extensively involved should be referred to a dermatologist.

PAPILLOMATA. See Figure 1550C. This term is often used to designate all sorts of epithelial elevations, including the common wart, which is caused by infection. Papillomata that may be classified as tumors are restricted to epithelial growths resulting from mechanical trauma, chemical and other forms of irritation. Both infectious and traumatic papillomata occur in the mouth; both are painless, smooth, firm or soft, pin-head to split-pea sized,



FIG. 1550B.

FIG. 1550B. Angioma of tongue. *Prinz and Greenbaum.*

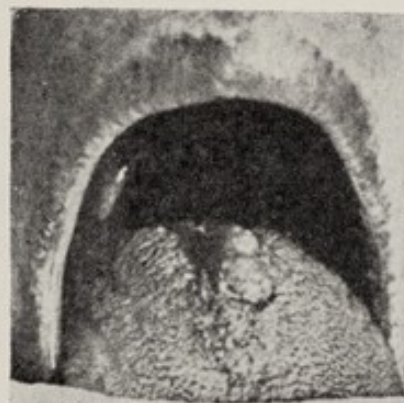


FIG. 1550C.

FIG. 1550C. Papillomata of tongue. *Fordyce.*

hemispherical elevations with a smooth surface and with or without a pedunculated base. Those which develop as a result of a definite point of irritation, as a jagged tooth, should be observed with suspicion in regard to possible malignancy. A papilloma may develop on any part of the oral mucosa; they occur most frequently on the tongue, and are usually single.

Infectious papilloma of the lip may be located on the mucous or muco-cutaneous surface. It fits the description given above, except that it is softer than the traumatic type, and its color may be gray or vary little from that of the mucous membrane. Traumatic papilloma results from persistent biting of the lip in one spot, the prolonged contact of a jagged tooth, or the irritation of a pipe stem. The lesion is usually firm and markedly fibrous. It may undergo malignant degeneration, and the change may be difficult to diagnose. (After Prinz and Greenbaum.)

TREATMENT. In all cases occurring in the mouth the growth should be removed either with the actual cautery or electric coagulation.

BENIGN GIANT CELL EPULIS. See Figure 1550D. There are two types of benign giant cell tumors, one of which appears as a growth on the gum, springing from the peridental membrane or periosteum of the alveolar process; the other involves the bone itself and destroys the central portion. The latter is called a central benign giant cell tumor. It is presumed that both types are caused by some form of irritation.

The growth on the gum — the epulis type — may be sessile or pedunculated. They are bluish in color, very soft and vascular, may appear as single or multiple lobes, and are composed of fibrous fibro-vascular and cellular tissue, including giant cells. These tumors, containing giant cells, are more likely to be pigmented than other epuli. They grow slowly at first and may become of firm structure, covered with mucous membrane of normal color. The size varies from that of a pea to a mass the size of a walnut. They are painless.



FIG. 1550D.

FIG. 1550D. Epulis. *Prinz and Greenbaum.*



FIG. 1550E.

FIG. 1550E. Ranula. *Blair and Ivy.*

TREATMENT. Tumors of this type should be removed surgically, and this should include the base to which they are attached. If the attachment is to the peridental membrane, the tooth should usually be removed, also a portion of the alveolar process, otherwise the growth is likely to return. An operation similar to a gum resection may be performed, removing some of the peridental membrane and alveolar process.

RANULA. See Figure 1550E. This is a peculiar type of cyst. It is a soft, painless swelling beneath the mucous membrane of the floor of the mouth, containing a clear ropy fluid. These cysts are due to an involvement of the incisive glands, but most commonly to the obstruction of the excretory ducts of the sublingual gland. Retention cysts of the Blandin-Nuhn glands are also classified as ranulas. (After Prinz and Greenbaum.)

TREATMENT. The treatment is surgical and consists of the removal of part or sometimes all of the cyst wall. The upper wall may be removed, leaving the floor of the cyst completely exposed. This operation should be performed by an oral surgeon.

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THE DENTAL PULP

Physical Functions and Physiological Reactions

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ILLUSTRATIONS: FIGURES 1551-1588.

THE dental pulp is the soft tissue which fills the pulp chamber and root canal, or canals, within the tooth. The structure of the pulp, the more important cellular elements and their functions will be described.

CELLULAR ELEMENTS. The mass of the tissue, particularly in the bulbous portion of the pulp, is of a gelatinoid character, very much like the gelatinous tissue of the fetus. It is therefore not a highly specialized tissue. This tissue is, however fairly well filled with cellular elements. See Figure 1551.

In the root portion these cells are fusiform and tolerably abundant. Each cell gives off a process from each end, which rapidly becomes smaller until it is a mere thread, which can be seen only with the highest power of the microscope. These threads wind about among the cells and through the gelatinous portion of the tissue, often filling it with the minute thread-like extensions. In the bulbous portion of the pulps of the molars, and in the larger pulps of the incisors and cuspids, the cells are more sparsely placed, and are larger. They may be round or cuboidal in form, each cell giving off a number of processes which radiate in every direction through the gelatinous mass, curving here and there. The fusiform cells in the root portion are disposed with their length parallel with the length of the canals, but in the bulbous portion this relationship is lost. In the root portion the cells are sufficiently numerous to form a fairly close network tissue. In the bulbous portion they are not so plentiful.

In a tolerably thick section brought under the microscope the cellular elements will seem plentiful, even in the bulb of the pulp, but if the section be a very thin one, the cells are seen to be separated from each other to such an extent that they fail to touch and unite with each other to form a complete network of cellular tissue, much of the gelatinous mass appearing as a clear space except for the windings of the very fine processes given off from the cells.

In the ordinary illustrations of pulp tissue, particularly in the photographs, little is shown of these very fine processes because they are too small to be shown in magnifications that may be used in illustrations in a book. Near the cell, a portion of the process, which is larger than the rest, is generally shown, but even this is absent from many photographs. Some idea of these processes may be obtained from Figure 1553.

ODONTOBLASTS. FIBRILS OF TOMES. All around the periphery of the pulp there is a zone in which the cellular elements are more closely placed, forming a somewhat higher grade of connective tissue, but even this is very imperfect. Upon the surface of the pulp tissue, between it and the wall of the dentin enclosing it, there is a layer of odontoblasts, in the form of fine columnar cells. Their principal functions are the building of the dentin, the maintenance of its vitality, and the transmission of the sense of pain. They also have the function of protecting the pulp from exposure by building secondary dentin in response to certain stimuli. This will be discussed in the consideration of calcifications within the pulp chamber.

The odontoblasts and other pulp tissues are shown in Figure 1553. Each of these cells gives off a cytoplasmic process which enters one of the dentinal tubules and passes from the pulp through the dentin, usually in a somewhat curved direction, and ends at the

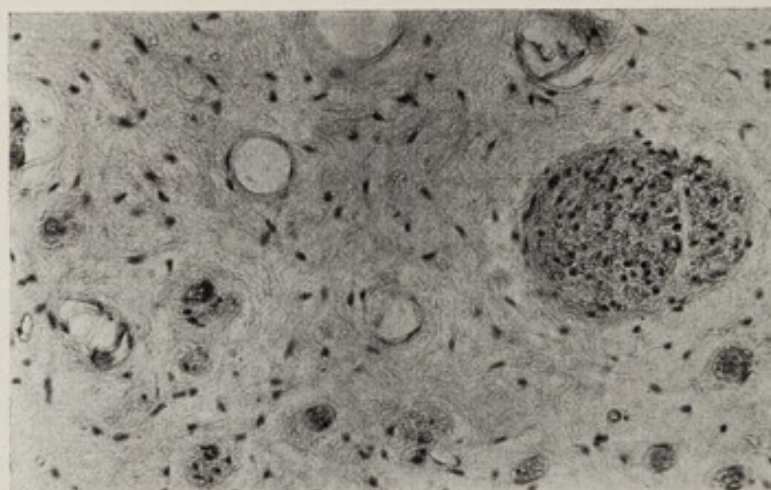


FIG. 1551. Cellular elements of the pulp.

dento-enamel junction in the crown portion, or at the dento-cemental junction in the root portion. These are the *fibrils of Tomes*, or the dentinal fibrils discovered by John Tomes, about 1840. These fibrils are shown in cross section in Figure 1554, and a single fibril, highly magnified, is shown in Figure 1555. Odontoblasts, with their dentinal fibrils, are illustrated in Figure 1556. These fibrils, which radiate through the dentin in every direction, give sensitiveness to this tissue. Each fibril is an extension from an odontoblast. The odontoblast itself is apparently a very sensitive element of the pulp tissue, and by means of the fibrils, conveys that sensitiveness from all parts of the dentin.

BLOOD VESSELS. The pulp tissue has a fairly abundant circulation of blood, conveyed to it by one or more arteries, accompanied by returning veins, which pass into it through the apical foramen in the fully developed tooth. See Figure 1557. In the formative stage of the tooth the blood supply is much more abundant, the

tissue of the future pulp having a broad base through which many arteries enter. As the growth continues and the pulp is narrowed down to adult dimensions of the pulp chamber, this blood supply is reduced more and more, until often there may be only a single minute artery entering the tissue, accompanied by a returning vein. This artery begins to break up in the canal portion of the pulp, sending branches to all parts, and this is continued even in the bulbous portion, until it is divided into fine arterioles, which approach the layer of odontoblasts previously mentioned. These again divide into a plexus of capillaries, which are especially abundant near the pulpal ends of the odontoblastic layer. The blood supply continues to be fairly rich in the pulp of the adult tooth.

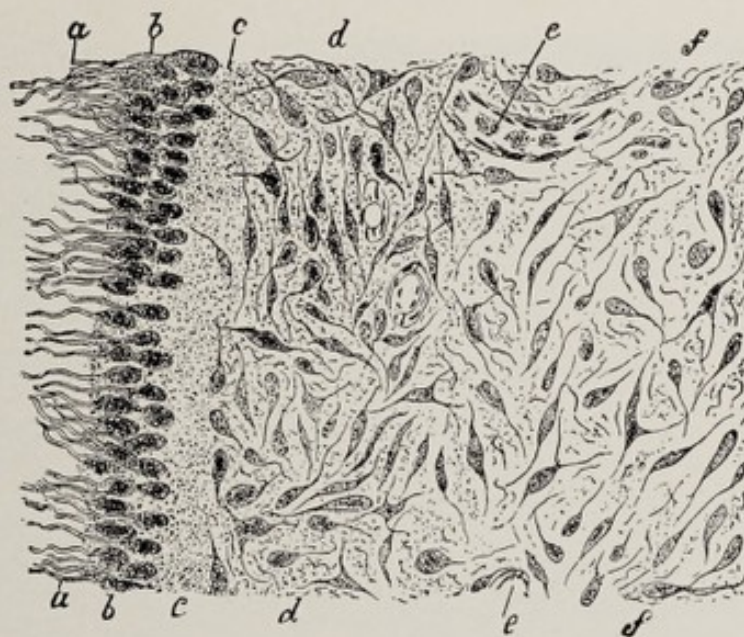


FIG. 1553. Drawing of cellular elements of the pulp.

The walls of the blood vessels of the pulp are unusually thin; this is another expression of the imperfect development of the organ from the connective tissue standpoint. See Figures 1551 and 1558. It seems that the pulp, being housed in the pulp chamber, where there is no opportunity whatever under normal conditions for any touch of extraneous matter with its tissue, is provided with blood vessels which have extremely thin walls. This may also be due in part to the fact that the tissue is housed and completely fills the space of the pulp chamber, and the blood vessels derive some support in that way.

At any rate, the walls of the blood vessels are very thin and the muscular coating of the arteries is very slight. This being the case, any unusual blood pressure is liable to expand some of the arteries, while others collapse to make room, and also the veins may collapse under any unusual blood pressure. This causes the pulp to be especially influenced by thermal changes. Each

thermal change, whether it is too hot or too cold, produces a shock which calls to the pulp a greater amount of blood, causing a twinge of pain which soon passes away. This is normal to the pulp.

LYMPHATICS. The lymphatic vessels of the pulp have been demonstrated by Schweitzer* and by Dewey and Noyes.† Noyes reports lymphatics attached to the walls of the blood-vessels of the pulp, also other lymphatics which are unattached to blood-vessels. The movement of lymph follows the general direction of the vessels through the apical foramen. About the root apex the lymph routes from the pulp are associated with those leading from the gingivæ through the peridental membrane. These lymphatics are of great importance in the study of infections of the pulp and peridental

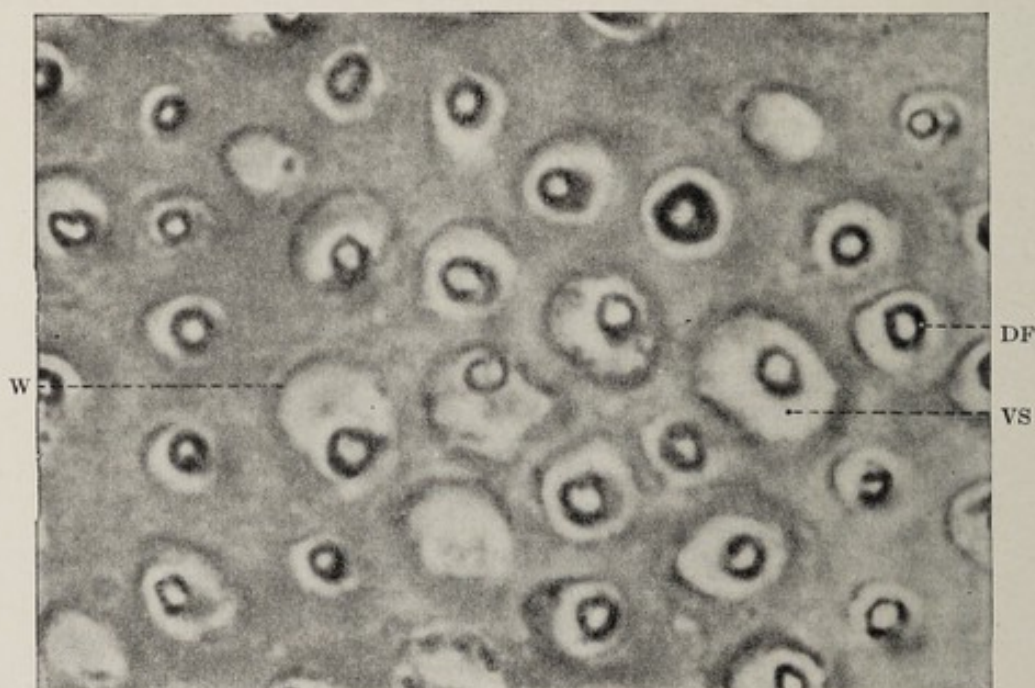


FIG. 1554. Cross section of the dentin, showing the dentinal tubuli with dentinal fibrils *in situ*. Hematoxylin-eosin staining Magn. $\pm 4000\times$. W, wall of tubule; VS, vacant space produced by shrinkage of dentinal fibril. DF, dentinal fibril. Some tubules are empty. *Meyer's Histology and Histogenesis*. Churchill.

membrane, as they have a part in the establishment of chronic foci of infection about the teeth.

NERVES. The nerve supply is derived from the nerve filament, or filaments, which enter the apical foramen. These are also distributed principally along the layer of odontoblasts, and nerve filaments are frequently found among or between the odontoblasts, their endings seeming to be upon the pulpal ends, or among the cells of the odontoblastic layer. These nerve filaments apparently do not enter the dentinal tubules. They give the pulp its sensitiveness, and the odontoblastic layer with its filaments conveys the sensitiveness from all parts of the dentin.

* Arch. f. Mikrosk. Anat. u. Entwickl., 1907, 69, p. 807; 1909, 74, p. 927.

† Dental Cosmos, 1917, Vol. 59, p. 436.

This is the one place in the minute anatomical structure of tissue in which sensitiveness without nerves seems to be demonstrable, and gives prominence to the idea that it is the cellular elements which are sensitive, and that it is the function of the nerve to convey sensitiveness. Nerves may have sensitiveness of their own, but the conveyance of sensitiveness or other impulses is the important function of nerve tissue. The sensitiveness of the cellular elements is carried by the nerves to the brain, and the expression of pain is produced upon the sensorium. That the cellular elements are themselves sensitive may be demonstrated by microscopic study of them under special conditions in which they can be seen while active.



FIG. 1555. Dentinal tubule with cytoplasmic extension of an odontoblast *in situ*. Hematoxylin staining. Magn. $\pm 5000\times$. W, wall of tubule; G, ground substance; VS, vacant space produced by shrinkage of dentinal fibril; O, odontoblastic extension; L, lumen of dentinal tubules. *Meyer's Histology and Histogenesis*. Churchill.

A large bundle of nerve fibers within the pulp is shown in Figure 1551, and the contacts of nerves of the pulp with the odontoblasts are illustrated in Figure 1556.

SENSORY FUNCTION OF THE PULP. In sensory function the pulp would seem to be similar to other connective tissues of the body. It exhibits pain upon touch, cutting or other injury of its substance. This pain is sharp and lancinating. The sensitiveness is more distressing than that of cutting the ordinary tissues. Every part of this tissue seems to possess this exquisite sensitiveness. In different states of irritability wide differences are found in the sensitiveness of the pulp. When laid bare by accidents which have broken the

teeth, exposing a considerable amount of pulp tissue, the pulp may be insensitive and blanched, showing its susceptibility to shock. The shock of breaking the tooth may obliterate sensation for the time, but it will return and the pulp will become red, hypersensitive and painful. Then the slightest touch will cause severe pain.

In the ordinary diseases of the pulp its exquisite sensitiveness is evidenced by the expressions of pain produced. Perhaps there is no other tissue in the body which becomes so sensitive as the pulp and exhibits more vague symptoms. This sensitiveness is perhaps due in large degree to the arrangement of its tissue, and the thin walls of its arteries and veins. In these the variations of pressure by the blood seems to have a marked influence, causing the pain to have a peculiar throbbing character.

PAIN AND TOUCH. The pulp is completely enclosed in the central portion of the tooth—the pulp chamber and root canals—and entirely fills this space. It is surrounded by hard tissue in

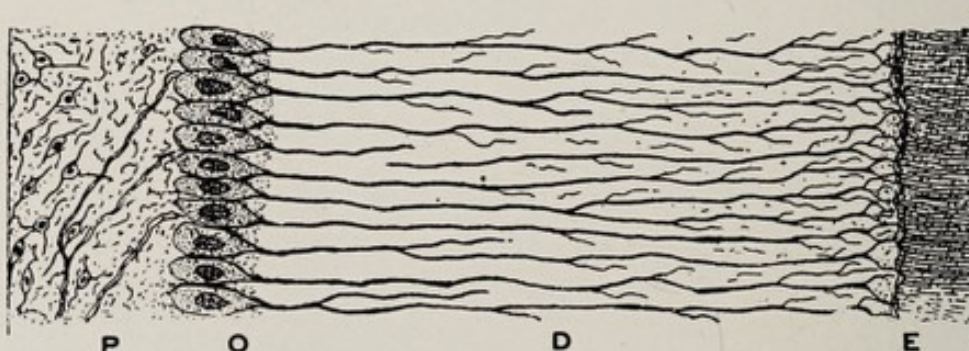


FIG. 1556. A diagram illustrating the transmission of pain through the dentin. E, Enamel. D, Dentin. O, Layer of odontoblasts. P, Pulp of tooth with nerve endings in physiological connection with the odontoblasts.

such a way that under normal conditions nothing extraneous can touch it, and would seem to be shielded very perfectly from outside influences, with the exception of changes of temperature. Under these conditions the pulp becomes an internal organ, and is subject to much the same conditions as to touch and pain as other internal organs.

The rule is that nature produces no functions which can not come into use. Consequently the sense of touch is absent from all of the internal organs, but resides in the skin and in the mucous membranes which line the entrances into the body, as the mouth, pharynx, etc., and the exits from the body. It exists in all parts that can ordinarily be touched by the fingers or by extraneous substances entering the body, but disappears as soon as those have fairly entered the body.

The sense of touch is a localizing sense and should be separated completely from the sense of pain. By the sense of touch we localize a touch on any part of the surface of the body. Pain in and of itself is not a localizing sense. Internal organs manifest pain in a vague way as to localization, and often the pain complained of is at some distance from the tissue in actual distress.

If a pulp has become exposed from decay in some hidden away locality, which has not been discovered by the patient or dentist, the patient is liable to locate that pain anywhere on that side of the face or head. It may be in the teeth or in the jaws, or at some distance from the teeth in the face, head, ear and various other localities, and may display a peculiar disposition to appear first in one place and then in another. This is liable to lead to errors in diagnosis. Patients frequently refer pain to another tooth than the one which is diseased; often to the opposite jaw. If there is another tooth in the same side of the mouth known to have a cavity, the patient is very liable to attribute the pain to this other tooth, an examination of which may show that the cavity is not of sufficient depth to be liable to produce inflammation of the pulp.

PAIN OF OTHER DISEASES MAY SIMULATE PULP PAIN. There are other diseases with which pulp pain may become confused because of the similarity of the symptoms. In cases of trigeminal

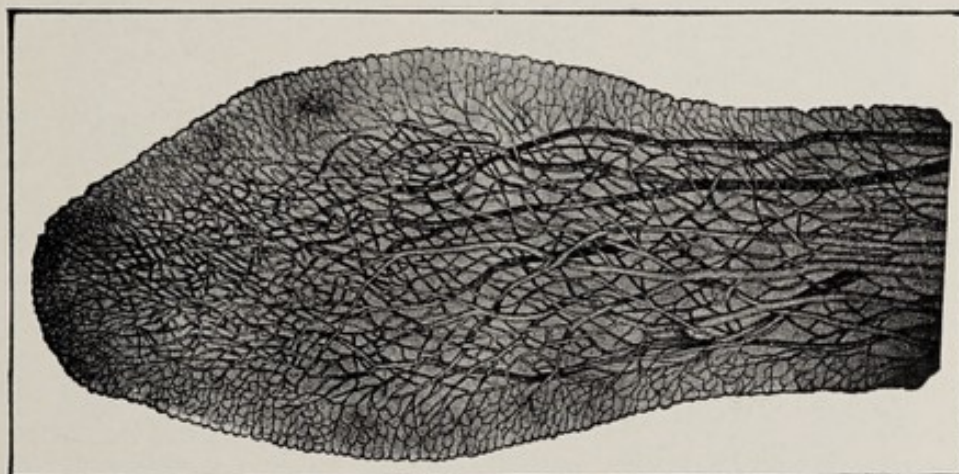


FIG. 1557. Diagram of the blood vessels of the pulp. C. H. Stowell.

neuralgia, particularly of the second and third branches, the pain may be confused with that caused by inflammation of the pulp. Referred pain from other regions may also simulate the pain of pulpitis. See the diagnosis of pain associated with oral lesions, Volume I, p. 81.

HEALING POWERS. The descriptions thus far given of the tissues of the pulp and of its functions indicate that the power of healing is not great in this organ, and this agrees with clinical observation. The rule is that in the adult tooth any touch of the pulp tissue in excavating cavities which is sufficient to draw blood, will eventually destroy the whole of the pulp. Such an injury fails to heal by any treatment yet devised. Some exceptions to this rule may have occurred under peculiarly favorable conditions, but the rule holds good for the very large majority of cases. This is partly due to the fact that the mutilation in these instances is of the very sensitive odontoblastic layer, the regeneration of which

when injured, is in great doubt. It is possible that in the child's tooth, before the full development of the roots, some of these injuries may be bridged over and in a very short time become perfect again, not by the multiplication of the odontoblasts, but by the falling together of the odontoblastic layer of the neighborhood and converging toward a common center. During the formative period the pulp chamber is becoming narrower and narrower, and the odontoblastic layer is becoming more crowded in the whole extent of its surface, making a more favorable opportunity for this bridging-over process in the growth of the dentin. In the adult tooth there is practically nothing of this kind to favor the healing process, and it is rare that wounds heal. They generally produce an inflammatory reaction which in the end destroys the pulp.

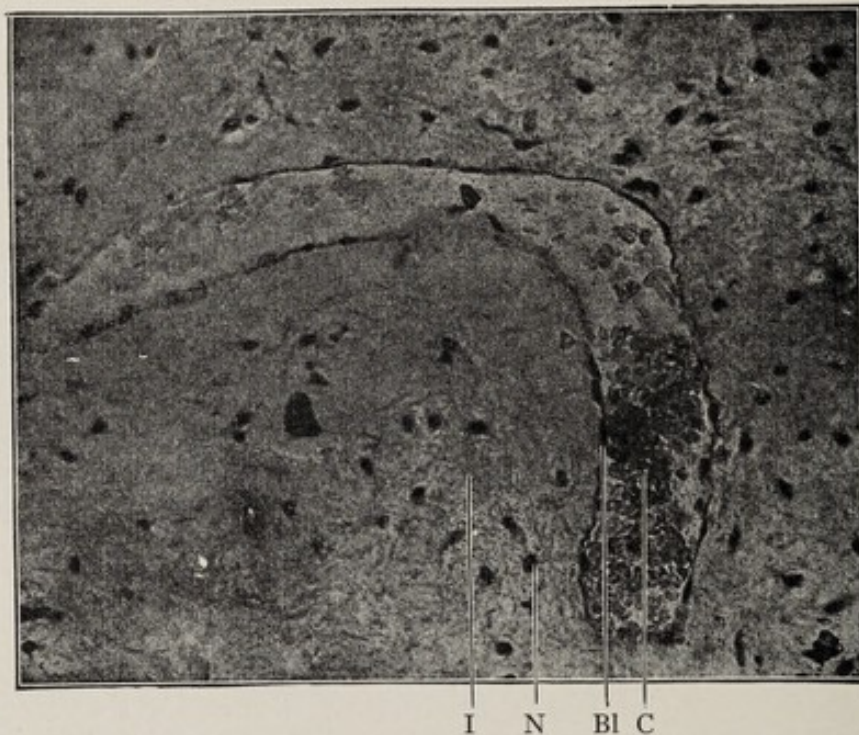


FIG. 1558. A pulp blood vessel, showing the thin wall: C, Blood corpuscles in the vessel. bl, Blood vessel wall showing nuclei of endothelial cells, N, Nuclei of connective tissue cells in the body of the pulp. I, Intercellular substance, showing a few fibers. *Noyes*.

Although but few dentists would to-day recommend the capping of pulps in adult teeth, there have been occasional attempts to revive the practice, generally by those unfamiliar with the history of such cases.

RESORPTIONS OF DENTIN. Cases occasionally occur in which more or less of the dentin near the apical end of the root canal is resorbed by the tissues of the pulp. When this occurs, there may be a rebuilding with a tissue which resembles cementum. No dentinal tubules are present in the new tissue, as the odontoblastic layer for the region is missing. The repair appears to be made in these cases by an extension from the cementum about the apical foramen at the root.

The History of Pulp Disease and Treatment in America*

GEORGE B. DENTON, Ph.D.

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BEFORE THE NINETEENTH CENTURY.

SOME of the procedures for the treatment of pulp disease are of very ancient origin. Besides extraction and toothache remedies, which are of too early origin to be investigated, three operations — luxation, plantation, and pulp extirpation — were practiced very early, at least as far back as the Arabian surgeons. Archigenes, in the first century of the Christian era, is said to have invented a technic for opening the pulp chamber. It is probable that he aimed merely at drainage, and there is no reason to suppose that he contemplated filling the root canal or cavity.

Destroying the pulp and filling the pulp chamber were not commonly practiced even up to the early part of the eighteenth century. Fauchard did not discuss the subject in his first edition, and gave probably the first detailed account of the practice in his second edition of 1746. In a chapter on trephining the teeth, Fauchard described his method of opening the pulp canals of the incisor and cuspid teeth, and of destroying the pulp. After gaining access by means of files, scrapers, and drills mounted in a brace, he pierced and removed the pulp by means of a needle or pin. He then inserted a dressing of cotton moistened with oil of cinnamon or oil of cloves, and renewed this from time to time over a considerable period. He gave no discussion of his method of filling in such cases, but it is unlikely that anything other than a cotton dressing, was placed in the root canal.

Bourdet (1757) probably somewhat extended the indications for the operation by including the bicuspid and, very rarely, the molars among the teeth to which it was applicable. He has been sometimes credited with filling the root canal to the apex. He was very explicit that the instrument for destroying the pulp should be inserted in the canal to its very end, so that the pulp would be completely destroyed; but the only roots which he indicated were to be filled were those of extracted teeth to be replanted, and his remarks would seem to indicate that he did not consider it possible to fill canals of teeth still in the mouth. Pulp extirpation and filling were carried on in much this same way until early in the nineteenth century.

* Abstracted from a History of Dentistry, in preparation.

BEFORE ARSENIC DEVITALIZATION—1800-1836

There were, during the first third of the nineteenth century, some more or less theoretical notions with regard to the physical character of the dental pulp, its structure, and reactions. However, scarcely any microscopic study of the pulp tissue had been undertaken. It was generally realized that the pulp contained blood-vessels and nerves. In some way the notion had grown up that there was a distinct differentiation between the peripheral structures of the pulp and the body of the organ. It was thought that this periphery constituted a separate membrane, generally referred to as the lining membrane, and was continuous with the peridental membrane, which was usually designated as the periosteum of the alveolus, or periosteum of the fangs. This notion led to the designations of external and internal periosteum of the tooth. As cementum was not known to exist on human teeth until after 1835, it was thought that the internal and external membranes both gave rise to the dentin, of which the root of the tooth was supposed to be wholly composed.

It was the prevailing theory that the function of the periosteum, both external and internal, in the fully formed tooth, was to furnish nourishment for the dentin, and that the crown of the tooth remained vital only through the nourishment furnished by the internal periosteum. This anatomy and physiology was most fully presented in the account given by Thomas Bell, 1829.

It was upon this latter interpretation that Leonard Koecker in 1821 based his dictum that all pulpless teeth should be extracted, since a tooth without a pulp was a dead tooth, and must of necessity—in accordance with the prevailing vitalistic pathology of the time—have a deleterious effect upon the surrounding tissues. The notion that dead tissue always acts as an irritant and caused disease in contiguous live tissue was the basis of the dominant school of pathology, and was applied to all diseases of the teeth. The progress of dental caries, the death of the pulp, the formation of periapical abscess, and even systemic diseases arising from the teeth, were explained as the progressive influence of dead tissue upon surrounding vital tissues.

The chief operations of the early nineteenth century in the treatment of involved pulps were (1) pulp extirpation and filling (2) pulp capping, and (3) crown excision. According to Koecker, the only way to save a tooth with an exposed pulp was by conserving the pulp through pulp capping. Practitioners who accepted Koecker's general principles, but were desirous of meeting the demand for conserving teeth with greatly involved pulps, or purulent pulps, devised the operation of crown excision. This operation consisted of removing the crown portion of the affected tooth, either by a single stroke, as with the special forceps invented by Fay in 1825, or gradually, by the use of the file. The root was left in the mouth as a kind of space retainer and preserver of the process, or

as retention for a post-crown. The theory was, of course, that the root still obtained nourishment from the external periosteum, and was thus vital; whereas the crown portion being deprived of its sole source of nourishment, the internal periosteum, was dead, and must be removed in order to prevent irritation and ultimate death of the dentin of the root.

Prior to 1836, live pulps were commonly destroyed by actual cautery, chemicals, and mechanical injuries. The chemicals commonly used were caustics or acids, such, for instance, as sulphuric acid and creosote. Broaches and flat blades passed along the wall of the pulp chamber were employed for removing the vital pulp; and pulps were "knocked out" by hickory pegs placed in the pulp chamber and given a sharp blow with a mallet.

The instruments used were probably all home made, barbed broaches being produced by filing or cutting a metal pin with a sharp knife. Two instruments of the sort used were described by Arthur* in 1852. His broaches were made from piano wire, annealed, cut into proper lengths, and fitted into sockets drilled in steel wire. They were filed down to various diameters, and burnished. There was then "cut upon them with a sharp knife, small beards, looking toward the handle of the instrument." Another home made instrument was an excavator in the form of a hoe, for enlarging root canals. This was made with the cutting edge at an acute angle with the handle, and was manipulated so as to cut when it was withdrawn. All the methods of pulp destruction were so painful that it is unlikely that much pulp canal work was done where live pulps were involved.

Because of the inaccessibility of the posterior teeth, root canal treatment was confined almost entirely to the single-rooted teeth until nearly the end of this period. The treatment of the pulps of molar teeth was described by Dunning in 1845, but was undoubtedly practiced by a few men some years earlier than this. J. D. White and E. Townsend claimed to have practiced it as early as 1840. Maynard probably performed the operation about 1837, and he believed that a Dr. Cherry of Alexandria, and Tucker, of Boston, treated molar teeth still earlier.

Throughout most of this period, however, few practitioners actually attempted to fill the root canals. Cotton moistened with one of the essential oils may have been placed in the canal, but the gold or amalgam filling was probably mostly confined to the crown. The earliest definite indication extant of an attempt to fill root canals to their apices, is in an itemized bill by Edward Hudson, dated 1825. Baker, who was probably first to mention this matter in a professional article, wrote in 1840, "the nerve being taken out, the internal cavity, after having been made perfectly clean and dry, should be immediately filled with gold to its highest point."

* *American Journal of Dental Science*, 1851-52, Vol. 2, 2nd series, p. 520.

The early practitioners of pulp extirpation could not have been altogether blind to the frequent bad results they obtained, especially the acute abscesses, sinuses, and painful teeth. Untoward results led to long delays in the placing of fillings, to the frequent removal of fillings to allow drainage, and to various methods of providing pulpless teeth with permanent drainage. The method of drilling a small hole through the tooth into the pulp canal near or below the gum margin, and thus providing drainage, was a favorite. Although practiced earlier, it was known in America about 1852 as Hullihen's operation. When possible, crowns were placed on devitalized roots, and an ingenious construction was sometimes employed, consisting of a hollow post which led to the periphery of the tooth, and was intended for drainage.

ARSENIC DEVITALIZATION—1836-1882

With the introduction of the perfected microscope about 1835, dental histology, along with histology in general, sprang into being. With respect to the dental structures, however, the study for many years was mostly limited to the hard tissues; and aside from its developmental relation to the dentin, the pulp was very little studied in this country before 1882, when Bödecker did some rather extensive work. It had already been recognized, however, that the odontoblastic layer did not constitute a peripheral membrane identical with the peridental membrane, and the latter notion gradually disappeared during this period.

The most potent influence upon pulp treatment prior to 1882 was the introduction of arsenic to the profession by Spooner in 1836, as an agent for devitalizing the pulp practically without pain. Although many of the old methods of devitalization were still practiced, and had their advocates, arsenic became the prevailing agent. It was not, however, immediately accepted by all the leaders of the profession. Untoward results, such as the loss of teeth, sloughing of the soft tissues, necrosis of the bone and even systemic poisoning, as a result of the use of arsenic, earned for its use considerable criticism and opposition. It was soon realized that some of the worst results were largely due to carelessness in the application of the drug.

The principal effect of the introduction of this new devitalizing agent was to extend the use of pulp extirpation and filling. In spite of a pathologic theory adverse to the operation, pulp extirpation became widely employed in response to the demand for the conservation of teeth.

Notwithstanding the fact that the use of arsenic did greatly lessen the patient's dread of pulp treatment, practitioners soon became aware that they did not yet possess a truly painless method of pulp removal. Various medicaments were added to the arsenic to eliminate its irritating effects. Among these were, first of all, morphine, and later, cocaine or phenol.

During this period, the types of operation other than pulp extirpation and filling, which were sometimes employed for the treatment of teeth with involved pulps, were replantation of teeth, amputation of pulps, and pulp capping. The first and last of these operations were not new, but had a new vogue during part of this period. The introduction of oxychloride cement about 1860 encouraged for a while the practice of pulp capping, but on the whole this operation was declining in popularity, and there were constant references in the literature of the time to failures of this method.

Pulp amputation was a new procedure, described by Chase in 1866, later presented in greater detail by Adolf Witzel in 1874, and given greater prominence by him in his book on the pulp in 1879. It seems never to have attained any great vogue in America, and was frowned upon by many leading practitioners, including G. V. Black.

At the beginning of the period there was considerable difference of opinion among the practitioners as to the extent to which root canals should be filled. Undoubtedly, the great majority of practitioners filled the canal only partly, or not at all. The tendency throughout the latter part of the period was to a complete filling of the canal, although the theoretical justification was not emphasized.

The chief filling materials employed were cotton impregnated with some medicament, such as creosote; gold foil; gutta-percha in one of its forms, such as Hill's stopping; and oxychloride of zinc. The earliest experiments with gutta-percha as a root canal filling seem to have been about 1860. As gold was generally considered the best root canal filling, gutta-percha was sometimes combined with gold in the root canal. It was not until about 1870 that gutta-percha began to be at all generally employed for root canals. Gutta-percha cones were mentioned as early as 1874. Chloro-percha was described by Colburn in 1848, but was not employed for root canal filling. Cotton impregnated with chloro-percha, or chlora-percha alone began to be employed for root canals in the early seventies.

THE SEPTIC THEORY—1882-1910

The greatest influence on pulp treatment, following the introduction of arsenic, was the septic or germ theory of disease, which began to be felt in dentistry about 1882, through the work of such men as Miller and Underwood. The latter clearly announced the principle and its application to pulp disease in 1882, in the following propositions: "Suppuration of the pulp and its sequelæ such as alveolar abscess depends upon the successful working of organisms;" and "the successful exclusion of germs would prevent the disease, and their exclusion is quite easy and practicable by the use of powerful and penetrating antiseptic agents."

Both G. V. Black and James Truman, writing in Litch's *System of Dentistry*, 1886, were inclined to believe that micro-organisms

played a part in the inflammation and suppuration of the pulp; but they were uncertain, and Black declared that he had "not yet been able to find the tissues of the pulp invaded by them." The immediate tendency of this septic theory was to simplify the situation to be dealt with in pulp disease, and to focus attention on thoroughness in the technic of the procedures. Black declared in 1887, "We may pass our broach through the apical foramen and wound and lacerate the tissues, and possibly provoke an inflammatory movement, but if the root canal and the instrument be aseptic, abscess cannot occur."

During this period studies were undertaken of the types of bacteria found in diseased pulps. The earliest of these was perhaps Gallipe and Vignal's work in 1889. Schreier, 1893, Miller, 1894, and others found various low-grade bacteria in the pulp; and the passage of these through the apical foramen was generally recognized as the sole cause of periapical abscess. The general theory was well stated by Black in 1887:

"Few men who have not had practical experience in the cultivation of microbes can form an adequate idea of the readiness with which they may be carried into the tissues of the apical space by the broach. I have often passed a surgeon's platinum suture wire, after having brought it to a glow to completely disinfect it, into a foul root canal, and then into stiff gelatine cultivating media, four, five, and six inches, and have seen the development of microbes along the track of the wire from end to end. If these organisms may be carried into a stiff gelatine in this way with a perfectly smooth platinum wire, what may we expect from a barbed broach thrust through a foul root canal into the tissue beyond? If this does not produce abscess, it will be because the root canal happened not to contain pus-forming microbes. In the cleaning of contaminated canals, and all root canals to which the saliva has had access should be regarded as contaminated, no attempt should be made to reach the apex before the introduction of a reliable disinfectant. The danger of forcing microbes through, into the tissues of the apical space, is so great that they should be destroyed before the attempt to reach the end of the canal is made. Then we may risk passing the broach to the very end of the canal, and not before.

". . . . Since we have learned that we can only have alveolar abscess after infection of an apical space with pus-forming organisms, we have an incentive to the performance of aseptic operations which we never felt before. To do this it is necessary to put on the rubber-dam, and disinfect the tooth or teeth included, and to disinfect all instruments used in the operation. For this purpose suitable disinfectants should always be on the operating table. It may appear to some that in case a pulp chamber is already open and infected, this precaution will be of little avail. Not so, for if the canals are already infected the first object will be to thor-

oroughly disinfect them, and to do this the source of infection should first be eliminated. Then, and not until then, should we expect to successfully disinfect the canals. The cavity should be perfectly sealed with a temporary filling of gutta-percha, or other suitable material. In no case should this filling be removed at a subsequent sitting, before the readjustment of the rubber-dam and the disinfection of the included parts."

Toward the latter part of the period, two improvements in diagnostic method were introduced; namely, vitality tests for the pulp by electric current, and the X-ray as a means of determining the condition of the periapical tissues. Although Magitot, as early as 1867, suggested the electric current as a means of determining the condition of a tooth-pulp; and various later experimenters, notably, Marshall in 1891, and Fuyt in 1901, made practical application of the method, yet it did not come into use generally in the profession until some time about 1909. The X-ray also, although discovered by Roentgen in 1895, was not utilized in dentistry as a routine means for diagnosing periapical abscesses until after 1910. Among the early American experimenters were Kells, 1896, and Price, 1901. The former did much toward improving the X-ray machine and roentgenographic technic for dental purposes, and eventually paid the price with his life.

Although most of the advancement in the period from 1882 to 1910 were determined by the discovery of the septic pathology of pulp disease and its sequelæ, the study of arsenic and other methods of pulp devitalization proceeded independently.

The most important study by an American dentist was that of J. Foster Flagg, reported in 1862. By experiments on the web of frogs' feet, he demonstrated the dispersion of the drug through the system by the circulation; and by experiments on the pulps of human teeth devitalized by the drug, was able to show the presence of arsenic in extremely minute quantity within the devitalized pulp. His conclusions for practice were that arsenic did not need to be applied in such large amounts as was common, and that long and repeated applications were unnecessary. He believed that the arsenic did not penetrate deeply into the pulp, being prevented by the destroyed tissue; and any periapical irritation, he declared, must be due to some other influence.

The problem of the effect upon the periapical tissues of arsenic applied to the pulp was undertaken by W. D. Miller in 1894. By means of some very ingenious experiments with arsenic applied to the tails of white mice, he arrived at the conclusion that the constriction of the root canal at the foramen prevented any destructive effect upon the peridental membrane. When arsenic was applied to the tails of the mice, swelling and edema occurred, and the hind parts of the animals became paralyzed. With mice, about the base of whose tails he had fitted glass rings to constrict them, the effects of the arsenic were limited to the tails.

As no investigator except Flagg had reported demonstrating the presence of arsenic in pulps after devitalization, Hermann Prinz devised a more delicate test, the results of which he reported in 1915. By the use of molds which give off a characteristic garlic-like odor when grown in a medium containing arsenic, he was able to show that arsenic was contained in very minute quantities in treated pulps. He calculated that one grain of arsenic could destroy 1,400,000 pulps, a result which agreed substantially with the findings of Flagg fifty years earlier. Prinz also concluded that arsenic acted as a protoplasmic poison.

Although much scientific study of arsenic in relation to the pulps was done in Europe, very little appeared in British or American journals.

With the introduction of cocaine in 1884 by Koller, for surgical purposes, a means was furnished for a more truly painless removal of the pulp than had been possible with arsenic. Besides attempts to combine cocaine with arsenic, efforts were made about 1890, to use cocaine alone, by applying cocaine crystals to the exposed pulp, and then gradually working the drug into the pulp with an instrument. More successful were the attempts at what was later called pressure anesthesia. Briggs (1890) employed a hypodermic syringe with a blunt point for forcing the cocaine solution into the pulp. The method of producing anesthesia by the application of pressure to an unvulcanized rubber pellet, which was laid over the cocaine, was developed, probably by Funk, at about the same time.

With the introduction of procaine (1905), painless extirpation of the pulp was made possible by means of hypodermic infiltration of the tissues about the apex of the root as early as 1906 by Harold S. Vaughan.

Not only were the older methods of enlarging canals by drilling and reaming continued and improved, but various chemicals came to be employed for softening the tooth substance and removing remnants of soft tissue from the canals. Emil Schreier of Vienna in 1892 announced the sodium-potassium method for this purpose. It consisted of the introduction of minute quantities of metallic sodium and potassium on a broach into the uncleaned root canal, which resulted in a transformation of the gangrenous tissue into a soapy material which was sterile and easily removed. Similarly, Callahan in 1893 employed sulphuric acid. His procedure was to introduce a solution of sulphuric acid into the canal and remove the softened dentin with a broach. This was followed by sodium bicarbonate to neutralize the acid and to give an explosive reaction capable of cleaning the canal of debris. Phenolsulphonic acid was introduced by MaWhinney and by Buckley about 1908 as a milder substitute for sulphuric acid for cleaning out root canals. Its use was strongly criticized by Prinz.

Strong antiseptics were also employed in the canal to destroy pathogenic organisms, and the chief question raised about any

sterilizing agent was its bactericidal effectiveness. Among the root canal antiseptics still commonly employed were corrosive sublimate, zinc chloride, and the essential oils. Others developed during the nineteenth century were creosote, phenol, iodoform, and formaldehyde.

During this period, naturally, the methods of preserving the pulp, or any part of it, were mostly in disfavor, and complete root filling was regarded as essential. The procedure of preserving an exposed or partly amputated pulp was given prominence by Miller before the World's Columbian Dental Congress, in 1893. He observed that "the solution of the problem was to be sought for in the direction pointed out by Witzel, except that our efforts should be directed not to retaining the vitality of the root-stumps, but to preventing their subsequent decomposition by impregnating them with a suitable antiseptic."

This type of treatment in its most ingenious and fullest development was represented in Percy R. Howe's method of silver impregnation of the pulp, 1917. This method consisted in the precipitation of metallic silver from a solution of silver nitrate and ammonia by the introduction of twenty-five per cent formalin. By this means Howe aimed to make it possible in one process to sterilize both infected dentin and pulp remains, and to transform the pulp into an inert body similar to a filling.

PERIOD OF ASEPSIS—1910 TO DATE

About 1910 there began to appear a change of attitude, which had its beginnings some years earlier. Two events were perhaps most influential in bringing about this change. The use of the X-ray had led to the discovery that the greatly improved methods of root canal filling which had been developed, had failed to accomplish the perfect filling of the canals. Furthermore, the X-ray revealed the frequency with which chronic periapical infections or "blind abscesses" existed without producing any local clinical symptoms.

In 1911 an address by William Hunter on oral sepsis was published. Although it mentioned pulp disease and its sequelæ only incidentally, it had a profound influence upon both the medical and dental professions through its emphasis upon the systemic effects of oral sepsis in general.

Surveys of large groups of clinical cases were made to determine the extent to which pulp treatment in practice might be regarded as successful. A. D. Black contributed a tabulation of regions of bone rarefaction about the roots of teeth in 6,000 X-ray films made for 600 persons of various ages, who were in average good health. This tabulation is reproduced on page 425.

The result of these influences was ultimately to divide the profession into two groups, those who came to believe that all pulpless

teeth should be extracted and a group who believed in the advisability of treating selected cases of pulp involvement.*

The new period, which of course includes the present, is characterized by a tendency upon the part of the profession to substitute study and caution for the complacency of the preceding period. The profession has been forced to make a closer analysis of the whole problem of pulp disease and treatment. This has been extended in all directions, as clearly manifested in the following phases: (1) A more extensive examination has been made of the conditions and structures with which the dentist has to deal in treating the pulp. (2) The adequacy of means of diagnosis, and the conclusiveness of their results have been criticized. (3) The properties and applicability of materials employed have been carefully scrutinized. The antiseptics employed have been especially investigated. (4) The problem of filling methods, especially with regard to extent, has been reopened. (5) Much attention has been given through microscopic study, to the results obtained by various methods of treatment.

The conditions presented in the pulp problem have been considered principally with regard to (1) the anatomical features of the pulp and the pulp chamber, (2) the nature of the micro-organisms and septic matter present, and (3) the histological study of the pathological lesion, both in the pulp and in the peridental structures.

Although the profession had known for years that pulp canals were not all simple, little emphasis had been placed upon the fact. Distinctions had been made between teeth with flat, narrow root canals, and those with well rounded orifices. If the canals were too fine, they were drilled and reamed out with broaches. Little emphasis was placed on difficulties of canal morphology which could not be overcome in these ways. Within recent years much has been written about the complexities of root canals, of multiple foramina, constrictions due to secondary dentin, of lateral canals, and the like. In America, Callahan had some appreciation of the variations in root canal as early as 1916, and since that time there have been numerous studies published in this country. A translation of Hess's book, summarizing the work done in Europe, appeared in 1925.

The bacterial factor in pulp disease has been further studied with regard to the types of bacteria present, their route into the pulp and periapical tissues, and the method of their producing infection.

In addition to the X-ray as a means of diagnosing periapical pathology consequent upon pulp disease, bacteriological diagnosis has been developed to a limited extent. An attempt has been made to distinguish between cases in which treatment will be successful,

* This problem is discussed in this volume in the chapter on Focal Infection, by Dr. Edward H. Hatton, also in the section of the chapter on Chronic Periapical Infections which is devoted to treatment.

and cases in which treatment will not be successful, on the basis of the bacteriological determination. Appleton, 1924 and later, developed such a method.

The X-ray, which at the beginning of this period furnished such an effective means of criticizing the results of pulp treatment, has, in turn, come in for criticism with regard to its adequacy. By comparison of X-ray results with bacteriological tests, investigators, such as E. L. Haden, in 1926, have undertaken to estimate the reliability of these methods of diagnosis.

The present period has been marked by a reaction against the use of strong antiseptics in pulp treatment. Experiments indicated that the periapical tissues were often seriously injured by medicaments commonly used in the root canals. Evidently the biological factor involved in the etiology of alveolar abscesses had not received sufficient attention. By 1911, G. V. Black came to the conclusion that antiseptics in the treatment of pyorrhea and pulp diseases were at best a necessary evil, and should be restricted in use.

There has also been a tendency to define more carefully what is meant by filling the root canal completely. Carl Grove and others have pointed out that the apical foramen passes through cementum, and that the ideal filling, in order to take the place of the pulp only, and not encroach upon the peridental membrane, should terminate at the dento-cemental junction. Callahan, in 1915, introduced a solution of resin and chloroform as a root filling, which could be "pumped" into the finer interstices of the canals in the apical region.

Histological studies of the results of root canal treatment have been somewhat discomfiting to the profession. The paper by Skillen, 1926, on "The Status of the Treated Tooth," indicates that, in practice, a very small proportion of root fillings even approximate the ideal technical requirements.

DISEASES OF THE DENTAL PULP

BIBLIOGRAPHY ON THE DENTAL PULP PAGE 411

THE most common pathological conditions to which the dental pulp is liable are hyperemia and inflammation. To these may be added hyperplasia, which occurs in some cases of chronic inflammation; traumatisms, including blows upon the teeth, broken teeth, and injuries to the pulp in the excavation of cavities caused by decay; and the calcifications which occur, either growing upon the walls of the pulp chamber, or within the pulp tissue unattached to the walls. These calcifications may cut off the pulpal ends of the dentinal fibrils and destroy the vitality of large areas of dentin, perhaps in some instances including the entire crown portion of the tooth. These occur most as a result of abrasions or erosions of the teeth, but may occur without them. This statement practically covers the diseases of the pulp observed by dentists in practice.

Previous to the publication of the American System of Dentistry in 1886, there seems to have been much speculative consideration of inflammation of the pulp, but a review of the literature reveals the fact that practically no studies of hyperemia of the pulp had been made before that time. Therefore, most of the cases of hyperemia must have been classed as inflammations. It does not appear that the diagnoses were verified by microscopic examinations of the prepared tissue, combined with previous studies of the symptomatology.

A number of writers have given extended classifications of inflammations of the pulp, apparently based on microscopical examinations of the tissue. These can not be distinguished clinically, and, therefore, are not useful to the general practitioner, so far as his every-day operations are concerned. They are interesting as scientific studies, and in the course of time a more critical observation of the symptomatology, as compared with the particular form of the inflammatory process, as studied in prepared sections, may become of more importance than at present.

From the standpoint of practical treatment, it is important that a differential diagnosis be made, whenever this is possible, between simple hyperemia and inflammation, because the effort should be made to save all hyperemic pulps, while practically all inflamed pulps must be removed.

In the consideration of the hard formations within the pulp tissue, it is of most importance that certain conditions which are known to cause these calcifications be recognized early and that treatment be promptly applied. A better knowledge of the various

forms of these calcifications will also be of assistance in facilitating their removal.

Studies were made by G. V. Black over a period of years to determine whether it might be practicable to so classify the symptoms of hyperemia and inflammation of the pulp that the two conditions might be generally recognized clinically. In doing this the symptoms were carefully written in many cases of hyperemia or inflammation of the pulp and from these a tentative diagnosis was made. The teeth were then extracted and a microscopic examination was made of the pulp tissue. As a result he was forced to the conclusion that inflammation of the pulp in earlier stages can not be differentiated from hyperemia; furthermore that it is often impossible to determine from the symptomatology, whether or not inflammation exists in the pulp. Many pulps which are inflamed and suppurating give no symptoms whatever. In the study referred to, widely inflamed pulps were classified as hyperemic pulps and many errors in diagnosis occurred.

Classifications of the inflammatory conditions of the pulp based on microscopic examination are of no value in making a clinical diagnosis. Therefore, in practice, the dentist must use a very simple classification which can be used as a basis for treatment.

Hyperemia of the Dental Pulp

ILLUSTRATIONS: FIGURES 1561-1564.

Hyperemia of the pulp consists essentially in the expansion of the blood vessels, principally the arteries, during any sudden abnormal blood pressure. This is of frequent occurrence; so frequent, indeed, that cases are almost constantly presenting. In general, hyperemia is seen as an accompaniment of another disease, and is not regarded as a disease in itself. If, however, a femoral artery is tied on account of an aneurism, and the circulation in the leg proves insufficient because of this, a general passive hyperemia of the leg may occur, often with fatal results. The venous hyperemia, which gradually approaches stasis, becomes a pathological condition, rather than a symptom. The hyperemia of the tooth pulp, in distinction from this, is always an arterial hyperemia.

ETIOLOGY. The most frequent cause of hyperemia of the pulp is a sudden change of temperature. Any sudden change from the normal temperature, either too hot or too cold, seems to affect prominently the blood pressure in the pulp, causing an inrush of blood which gives a more or less sharp twinge of pain for the moment, and then passes away. This is a *physiological hyperemia* of the pulp. Practically every normal pulp will give this expression when either ice-water or a hot drink, or very hot or very cold food of any kind, is taken into the mouth. This is not abnormal, but normal to the pulp. *Pathological hyperemia* is an extraordinary excitation, in which the function is forced beyond normal limits, and the larger majority of cases are brought on by sudden ex-

posures to heat or to cold, which are sufficient to cause this normal function to become excessive and morbid.

There are some other conditions which produce hyperemia of the pulp. Irritation of the dentinal fibrils in the beginnings of caries seems sometimes to render the pulp more excitable, and may serve to precipitate a case of hyperemia. This occurs most frequently as a result of broad gingival third decays in the buccal surfaces of the bicuspid or molars, or in the labial surfaces of the incisors, in which the ends of many dentinal fibrils are laid bare.

Hyperemia is very commonly the result of heat generated in polishing metallic restorations, either by rapidly revolving disks, or by the vigorous drawing of tapes back and forth on proximal surfaces. A restoration which is placed over a nearly exposed pulp may cause hyperemia by the rapid conduction of thermal changes. A very large restoration may cause a hyperemia on account of the broad contact of its inner surface with many dentinal tubules, even

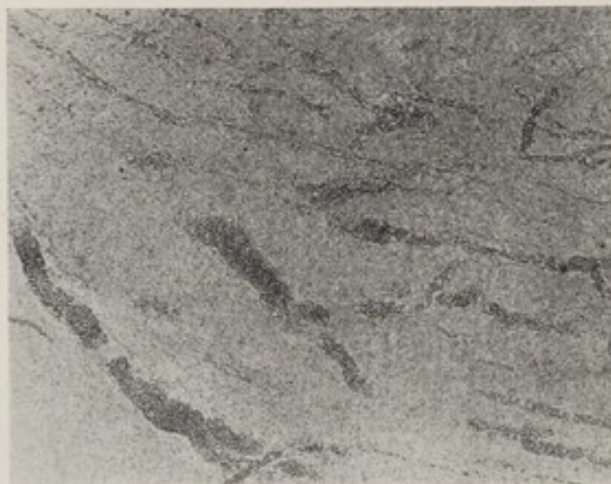


FIG. 1561. Hyperemia of the pulp.

though the changes of temperature in the mouth are not extreme. The grinding away of the enamel of a vital tooth will often cause hyperemia, either on account of the heat or by the irritation of the ends of the dentinal fibrils at the dento-enamel junction, even though the tooth is kept cool by a jet of water or otherwise. Hyperemia may be caused in testing teeth to determine the vitality of the pulps, by applying gutta-percha which is too hot. This will produce severe pain at the moment, and the teeth may be hypersensitive for some time afterward. The condition of the blood vessels in hyperemia is illustrated in Figure 1561.

PATHOLOGICAL CHANGES. In the majority of the milder cases of hyperemia in which the teeth have been extracted during the time of freedom from pain, practically nothing abnormal is found. They would be passed as normal in any collection of microscopic specimens of tissues of the pulp; but in similar cases, in which the teeth were extracted during paroxysms of pain, considerable blood

over the normal amount is always found in the arteries, and some of the arteries are more or less expanded in parts of their course.

Some cases, in which the history showed that the paroxysms of pain were very severe and of long duration, the arteries were found to be expanded and congested, even though the teeth were extracted during the time of the most complete cessation of pain. In those cases in which the tooth was extracted at the moment of severest pain, the normal arrangement of the arterial system of the pulp was very greatly changed, as illustrated in Figures 1563 and 1564. Some arteries were greatly expanded and filled with blood, while others near by were collapsed. Distortions of this

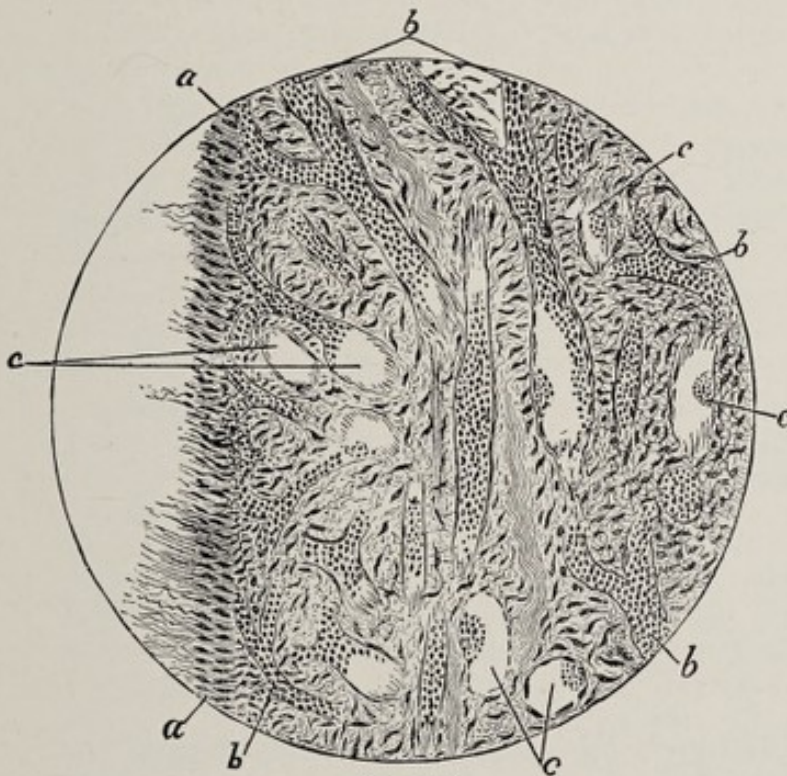


FIG. 1563.



FIG. 1564.

FIG. 1563. Hyperemia of the dental pulp, showing the natural injection of the vessels: a, a, Layer of odontoblasts. b, b, b, b, Vessels distended with blood, c, c, c, c, Points from which the blood has fallen in handling the section.

FIG. 1564. Dilated blood vessels from the dental pulp in hyperemia, from tooth extracted during a paroxysm of intense pain.

character were seen throughout the tissue of the pulp. In none of these was there an actual sign of inflammation.

In those cases in which the pulp had just died, or in which its death had occurred within a few hours previously, this distortion of the tissues of the pulp was very much greater, and in addition to this the tissue was generally very much filled with red blood corpuscles which had passed through the walls of the blood vessels into the tissues, causing the pulp to appear almost like a blood clot.

DIAGNOSIS. The symptoms of hyperemia consist of varying degrees of pain. Many cases produce a moderate excess of pain

in a particular tooth, or in several teeth, which endures a little longer and is more severe than would be called the normal condition of pain as a result of food or drinks that are hot or cold. Some patients are much disturbed when a tooth is sensitive to heat or cold, even though the increased sensitiveness may be of short duration. From this slight degree of hyperemia there may occur paroxysms of pain which will last for some minutes, or even half an hour or more, and then subside. Occasional cases occur in which there is more or less pain almost continually, and changes of temperature of three or four degrees are sufficient to cause paroxysms of extreme pain.

All cases of pain which may be induced by hot or cold applied to the tooth should be considered as hyperemia, provided there is no exposure of the pulp to carious dentin. If decay has reached the pulp, it should be considered as an inflamed pulp. A test may be made with hot gutta-percha or ice placed in contact with the tooth, or with an electric pulp tester. The teeth adjacent to the suspected tooth should be tested first to determine the approximate heat or cold or amount of current that will elicit a mild response. A tooth with a hyperemic pulp should respond to the same test very promptly with considerable momentary pain. Freedom from pain after severe and often repeated or long continued hyperemia usually indicates the death of the pulp, which occurs from strangulation, as the enlargement of the arteries prevents the blood from escaping through the veins.

SEQUELÆ. As the paroxysms of pain become more severe or of longer duration, some of the arteries are generally expanded, while other arteries and the veins are collapsed to make room. It is but one more step to a complete stagnation of the circulation in the pulp, and the death of the organ. This is called *infarction*.

When a pulp dies of hyperemia, there occurs a solution of the red corpuscles which have escaped into the tissues. This coloring matter penetrates into the dentin, often causing a marked discoloration of the tooth, which is very difficult to bleach. This discoloration may be compared to the discoloration of the soft tissue which occurs about a contused wound. In the latter, however, the color is gradually changed to normal by the circulation, but a similar change can not occur in the tooth. When the death of the pulp is promptly discovered and the pulp removed, the discoloration may be prevented.

Cases which terminate in the death of the pulp often result in the formation of either an acute or chronic periapical abscess. When the pulp dies, the patient is free from pain and no further thought is given to the tooth, the supposition being that it has recovered. The case may go for years without involvement of the periapical tissues until possibly, without apparent cause, an acute abscess suddenly develops, or a chronic abscess may develop and gradually destroy the bone about the apex of the root.

Inflammation of the Dental Pulp

ILLUSTRATIONS: FIGURES 1565-1571.

The pulp becomes inflamed from injuries or infections the same as other tissues of the body, but has not the same powers of recovery. It also suppurates quite commonly when it becomes inflamed. This suppuration is identical with suppurations in other tissues of the body, but the results of suppuration are especially destructive in this small bit of tissue, the more so because of its embryonic type and its low degree of the power of resistance.

ETIOLOGY. The most common cause of inflammation of the pulp is dental caries which has progressed sufficiently to involve the pulp or to expose it by laying it bare.

In decay of the teeth the dentin may be softened about a portion of the pulp tissue without the complete destruction of the dentin covering the pulp. It has been a favorite hypothesis among dentists that such softened dentin could act as a protection to the pulp, and it has even been incorrectly held that it would become hardened again. After medication, which has taken a pretty wide range from the strongest to the mildest antiseptics, a nonconductor has been placed over the softened dentin; or a nonconductor has been placed over it without other treatment. Careful study of these forms of treatment with records have shown that the death of the pulp has generally occurred within a variable time, regardless of the treatment employed.

In caries of the teeth, the acid-producing micro-organisms grow into the dentinal tubules after an opening has been made through the enamel. The acid always penetrates the tubules of the dentin in advance of the growth of the organisms, both following the length of the tubules progressively. The dentin is thus penetrated, until the pulp is finally reached. The acid softens the dentin, and these organisms and others, including those that produce inflammation and suppuration, which follow the progress of the organisms producing decay, all together destroy the softened tissue. Therefore, very soon after the softening of the dentin has reached the pulp, micro-organisms of various sorts may come in contact with the pulp tissue and infect it.

Inflammation of the pulp may result from its exposure in cavity preparation. When the excavating is done without sufficient regard for the depth of decay, or for the form of the protrusions of the horns of the pulp into the crowns of the teeth, particularly in the bicuspid and molars, many exposures will result. Generally a touch of any part of the pulp in excavating will be sufficient to set up an inflammatory movement which will cause its death.

The pulp may be exposed by breakage of the tooth, or other violence which crushes or destroys such portions of the hard structure of the tooth as will lay the pulp bare. Occasional cases occur

in which the pulp dies as a result of a blow upon the tooth which does not fracture the tooth. The pulp evidently dies as a result of the injury to the tissues about the apex of the root. This occurs most frequently in the incisor region.

PATHOLOGICAL CHANGES. Inflammation of the pulp in the tooth of an adult practically always results in its death. This has been referred to in a previous chapter in considering the healing powers of the pulp.

Generally in those cases in which decay has reached the pulp, but it is still covered by softened dentin, the pulp, upon microscopic examination, will show a small area of inflammation within the part of its tissue. See Figures 1565 and 1566. This area is particularly liable to be small if no symptoms have occurred. In

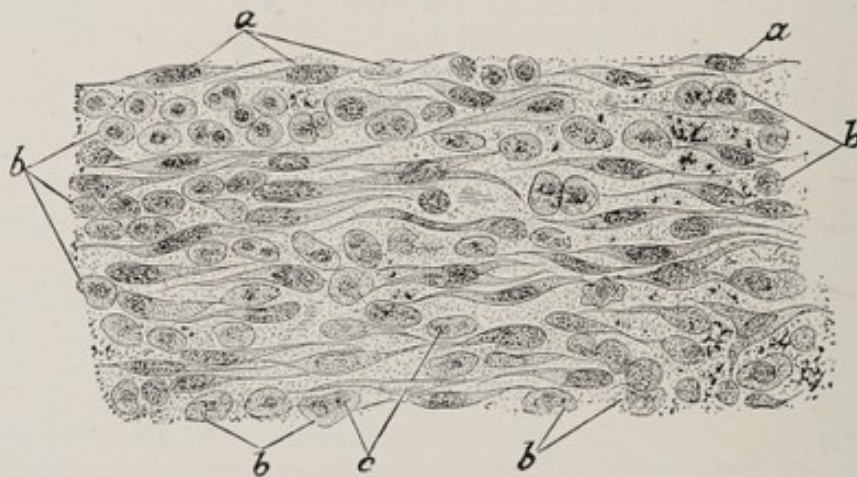


FIG. 1565. Inflammation of dental pulp: a, a, Normal cells. b, b, b, b, Inflammatory elements, c, Cells in process of division.

cases in which symptoms have occurred, the area of inflammation will be found broader as the rule, although, as already stated, the symptoms are generally the same as those in hyperemia. In many of the cases in which very considerable pain had been invoked during the inflammatory process, the pulp tissue was found to contain small abscesses, or abscessed cavities, which seemed to have been associated with the excessive exacerbations of pain. See Figures 1567 and 1568. However, in a few other rather widely inflamed pulps, giving the same symptoms, there was no evidence of abscesses when the pulp was examined microscopically. This makes the general correctness of the subjective sign of abscess formation uncertain.

Some years ago a case presented an unusual opportunity to study suppuration of the pulp, the patient refusing to have the tooth removed. Abscess after abscess occurred in the bulbous portion of the pulp, which was exposed by a cavity of decay in a lower molar and easy of access. It is interesting to note the relation of pain to this abscess formation. In the first instance of

lancing the abscess, the patient refused to have the pulp removed, although he was in great pain. The point of a very sharp eye-knife was passed into it and a goodly drop of pus was discharged. This rendered the patient comfortable at once. In about a week he was again suffering and the same process was repeated with the same result. This was repeated five or six times within about as many weeks. The abscesses always caused intense pain which was relieved by the discharge of the pus. But this pulp was losing tissue continually during this time, until there was not very much of the bulbous portion left. The patient finally accepted the extirpation of the pulp.

ACUTE PULPITIS. The one determining sign that inflammation has begun in the pulp is the finding by careful removal of all decay, that the pulp has been exposed to carious dentin. If it has, it should be considered an inflamed pulp, whether it has given any



FIG. 1566. Inflammation of pulp.

symptoms or not, and treated accordingly. If, however, it is still covered by hard dentin, it should not be regarded as an inflamed pulp, no matter what the symptoms have been. It should be considered to be hyperemia until such time as symptoms of inflammation become apparent. This is the most certain way to determine clinically between inflammation and hyperemia of the pulp.

PAIN. Pain is a very usual symptom of inflammation of the pulp. In very many cases, the progress of the inflammation is very quiet, producing but little pain. It is not uncommon for pulps to die from inflammation and suppuration, giving no symptom. This may occur whether the pulp chamber is open or closed. However, paroxysms of pain are liable to be induced by thermal changes, giving the symptoms of hyperemia. The pain may be very severe and last for hours. It is likely to be more severe when the patient lies down. If not relieved, it may gradually subside for a time and then return in another paroxysm. The pain may be of

such excruciating character as to almost rob the patient of reason, if it continues for a considerable time without attention or abatement. It is doubtful if any other type of pain is more severe than that occasionally caused by an inflamed pulp.

CHRONIC PULPITIS. Chronic inflammation of the pulp occurs in many cases, though they are exceptions to the most general rule. The pulp will sometimes become exposed and give no sign in the way of pain except when pressed upon by something forced into the cavity in chewing food. The patient learns to avoid such injuries, and goes on with comparative comfort, chewing his food on the other side of the mouth. After some months or years possibly, the pulp will die either as a result of the chronic inflammation or an acute infection. Such cases are usually followed by periapical abscess unless they have prompt attention. See Figure 1570.

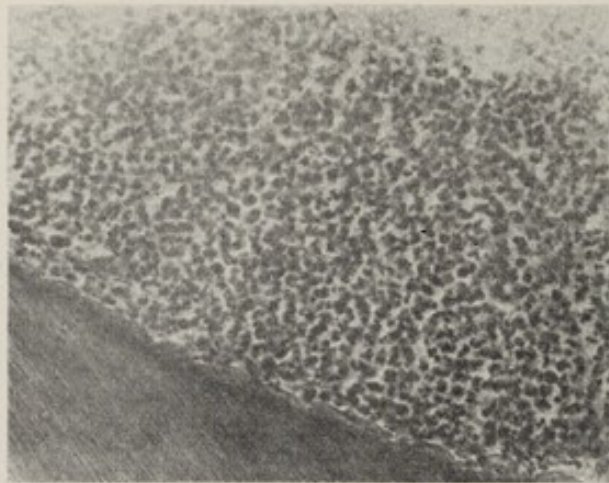


FIG. 1567. Suppuration of pulp.

Sometimes cases persist in a state of chronic inflammation for several years. Such cases do not respond to other than palliative treatment. The attempt to cover them over with any kind of a capping generally results in the speedy death of the pulp. Some exceptions to this rule are found, but they are not sufficiently frequent to be entitled to consideration. Figure 1570 is from a case of chronic inflammation of the pulp.

In many cases a pulp that is not exposed will be involved in a chronic pulpitis. These oftentimes occur subsequent to the placing of a restoration too close to the pulp. There may or may not be symptoms of a mild hyperemia. Extremes of temperature may cause pain in moderate degree. When the pulp is partially dead, it may still respond to any one of the tests mentioned. Occasionally, in multi-rooted teeth, the pulp tissue in one root may remain vital and respond to a test, while that in the other root or roots may be purulent. It might be said that the sharper and more frequent the pain, the earlier will the death of the pulp occur, while

if the patient suffers little discomfort, the pulp may continue in a state of low grade inflammation for months or years before it eventually dies.

In chronic pulpitis, the attention of the patient may at no time be called to the tooth, but there will be complaint of referred pain almost anywhere in the head or neck, and possibly in the chest or abdomen. A case may be cited of a woman forty years of age, who had made the rounds of several physicians for the relief of severe attacks of pain in the left side of the head, particularly in the parietal and occipital regions, at intervals of two or three weeks over a period of about two years. On many occasions she was confined to bed for two or three days. In making an examination of her teeth, a history was obtained of the removal of the lower left third molar two years previously, also that the second

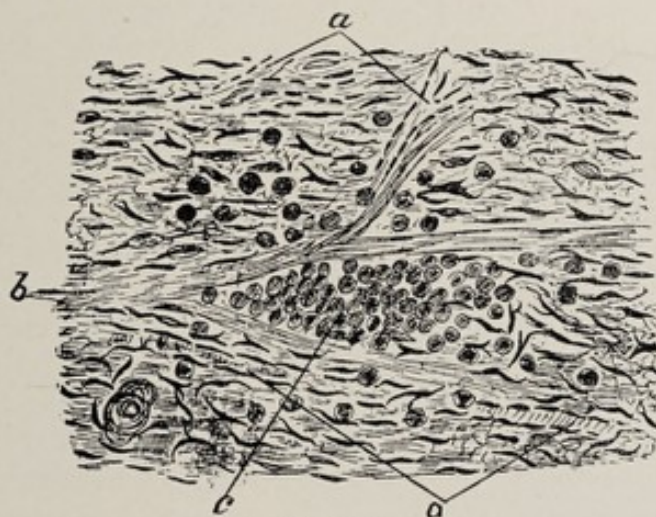


FIG. 1568.

FIG. 1568. Minute inflammatory focus within the tissues of the pulp: Arterial twigs. b, A nerve bundle, c, Collection of leucocytes.

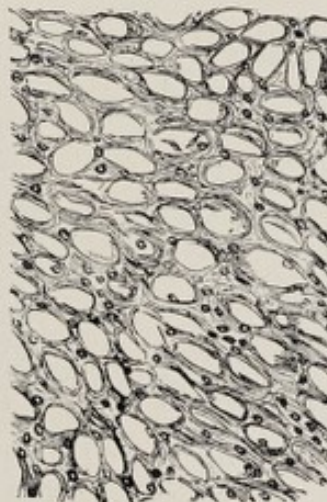


FIG. 1570.

FIG. 1570. Chronic inflammation of the pulp, areolation and degeneration.

molar crown had been broken at the time. There was a disto-occlusal amalgam restoration in the second molar which included practically all of the disto-buccal cusp. This tooth gave a definite, though rather weak response to the electric test. The bone about the apices of the roots appeared to be normal, and the tooth had never been tender to pressure. It was extracted in the belief that a chronic pulpitis was very slowly destroying the pulp. The patient has had no return of the headaches during three years that have elapsed since the removal of the tooth. The tooth was split after its removal, and the pulp tissue appeared to be intact and vital.

HYPERPLASIA OF THE PULP.

Hyperplasia of the pulp occurs in a few cases of chronic inflammation of the pulp, in which a considerable cavity in the tooth has occurred, making a broad exposure of the organ. Its tissues will swell and be forced out into the cavity of decay through

the opening into the pulp chamber. This growth of tissue may enlarge until it entirely fills the carious cavity. Figure 1571 is a section through a hyperplastic pulp. The bulk of the growth is made up of highly vascular granulation tissue, the outer surface of which is covered with a layer of hyperplastic, infiltrated, deformed epithelium.

DIAGNOSIS. The diagnosis of hyperplasia of the pulp is very simple, for the cavity is filled more or less completely with a reddened, fleshy material, with which the opposing teeth often come in contact. It is easily seen, whether or not it completely fills the cavity. It often happens that the portion of the pulp exposed in this way becomes covered with epithelium which has been transplanted from the neighboring gingivæ and grows there the same as will epithelium planted upon a granulating surface.



FIG. 1571. Hyperplasia of pulp.

This hyperplastic tissue is generally not painful, except when the patient bites something down upon it. One soon learns to avoid this, chewing mostly on the other side of the mouth. Therefore this unused side is apt to become unclean, and the gums more or less reddened and inflamed.

In the further diagnosis of this condition and the differential determination from a growth of the septal gingiva which may fill a carious cavity and have precisely the same appearance as this growth of pulp tissue, one may pass a thin, flat instrument into the gingival crevice, close to the cemental line, and move it toward the occlusal, keeping it against the proximal surface of the tooth. If it may be passed out to the occlusal readily, without displacing or lifting any of the tissue, the growth is from the pulp. If the tissue is caught and lifted, the growth is from the septal tissue and not from the pulp, for in that case the septal tissue protrudes into the cavity of decay.

TREATMENT. If it is found to be a protrusion of pulp tissue, a very broad spoon excavator, the edge of which is sharp, should be passed down between the cavity wall and the growth, and then swept across under the tissue, keeping it close against the walls of the cavity, cutting the whole mass loose from that portion of the pulp within the pulp chamber. If this stroke is successful, the growth will all be removed. If not, the stroke will have to be repeated to loosen the remaining portion. This cutting causes a slight pain and a profuse hemorrhage. The hemorrhage will stop in a few minutes and the blood may be washed away and the cavity inspected. The hyperplastic tissue may be removed with the cautery or by electric coagulation. However, as a rule, these growths are not sufficiently sensitive to cause pain of consequence.

These growths have no malignancy. In cases in which there is a hyperplasia of the pulp, the pulp itself should, of course, be removed. The stump of the pulp remaining in the pulp chamber may then be treated for its removal the same as any other exposed pulp. It may be desensitized in the usual way.

Calcifications Within the Pulp Tissue

ILLUSTRATIONS: FIGURES 1573-1588.

In this writing, the effect of these growths upon the tissue of the pulp will be presented, classifying them into a few specific forms. A limited number of these, if not excessive in their growth, are beneficial in their effect, but nearly all of them are injurious. They must generally be regarded as pathological.

CLASSIFICATION. They may be divided into two classes; each of these may be again divided for identification:

Calcifications attached to the walls of the pulp chamber may be divided into three groups:

1. Those in which the tubules are continuous with those of the ordinary dentin; these are called secondary dentin.

2. Those which are continuous upon the walls of the pulp chamber; beginning as secondary dentin, but in which the dentinal tubules progressively disappear and the growth continues as a nontubular, clear calcification.

3. Those attached to the internal wall of the pulp chamber, which are nontubular, clear calcifications from the beginning. In any of these, calco-spherites, or small nodules, which have previously formed free in the tissues of the pulp may occasionally be included.

Calcifications growing free in the tissues of the pulp may be divided into four groups:

1. Nodular formations, growing free in the tissues of the pulp, usually confined to the bulbous portion of the pulp. These may or may not contain calco-spherites.

2. Fusiform calcifications, occurring in the root portion of the pulp. These are usually disposed with their length parallel to the length of the canal.

3. Jointed calcifications in the root portion of the pulp.

4. More extensive growths of calcific materials, which fill up the pulp chamber, sometimes including more or less of the contents of the canals, especially in the molars.

This classification does not include all of the forms which may be seen. Each specimen presents some special points of difference, no two being exactly alike. The classification of a great variety of forms is of little value to the practitioner, since one may not be able to make a diagnosis except occasionally by radiographic examination, or by finding them after the pulp chamber



FIG. 1572. Secondary dentin: A, Margin of primary dentin, showing a few of the tubules continuing into secondary dentin. P, Pulp chamber. *Noyes.*

has been opened. Some of the conditions can not be definitely differentiated without a microscopical examination of the pulp tissue.

Some calcifications are caused by abrasion and erosion in which the filling up of the pulp chamber with hard material is sufficiently evident to the naked eye, or in the radiographic film. In cases of erosion, the teeth are generally sensitive when the dentin is first involved, and become gradually less sensitive as secondary dentin is formed. In abrasion, there is usually no discomfort, although the teeth may be sensitive for a time after the first involvement of the dentin. Caries may occasionally, when its progress is extremely slow, cause the formation of secondary dentin; if the tooth has been sensitive, the sensitiveness will, as in other cases, disappear when sufficient secondary dentin has been built to cut off the connections of the tubules with the odontoblasts.

CALCIFICATIONS ATTACHED TO THE WALLS OF THE PULP CHAMBER.

Under this heading those calcifications generally known as secondary dentin will be described. While these present the differences previously enumerated, they are so intermingled that it seems best to consider them together, as a single class, presenting the variations noted in the several groupings. The tubules continue regularly into the new formation—true secondary dentin, or they may be missing in some parts of the new growth. Quite a large proportion of the new growth may be nontubular, clear calcification, or the complete cutting away of the tubules may mark the beginning of the new growth throughout its attachment to the original dentin. The new growth begins upon the walls of the dentin, the tubules running across the line of the beginning new growth, but generally with enough of deviation of their course,

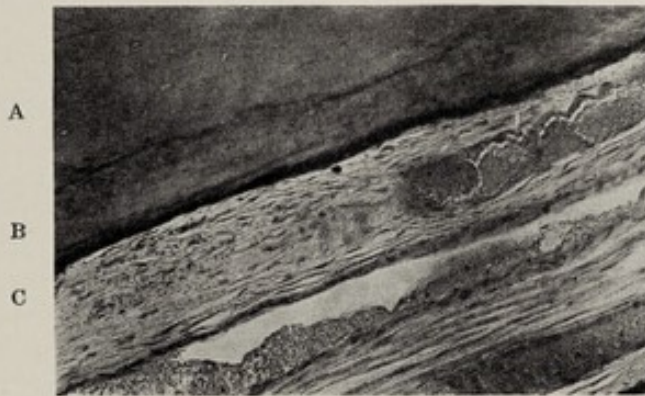


FIG. 1573. Calcifications of pulp chamber walls. Normal dentin, A; bone-like calcification, B; cementum-like calcification, C. The odontoblasts have disappeared.

or a reduction of the caliber of the tubules for a little space, to show quite distinctly the line where the new growth began.

Figure 1572 shows a building of secondary dentin, a part of which is clear calcification and a part tubular. The inner margin of the primary dentin is at A, the pulp is at P. All of the dentin between is secondary. The tubular dentin beyond the two regions of clear calcification is evidently an extension from a different plane than the primary dentin shown below, as the tubules are cut diagonally.

In Figure 1573 the normal dentin is marked A, a layer of clear bone-like calcification B, and a second layer is more like cementum, C. This is from the root portion of a tooth. The remaining pulp tissue has changed to a more fibrous tissue and the odontoblasts are missing.

In these growths more or less reappearance of dentinal tubules may occur in irregular forms, but they rarely straighten into regular dentin formation; much will be simply clear calcification. These generally are continuous upon the walls of the pulp

chamber, but are found upon the walls of the root portion as well. The growth occurs on the root-wise portion of the double and triple rooted teeth, or in the floor of the pulp chamber, much the same as upon the occlusal portion and axial walls of the pulp chamber. In some growths, which begin at a single point upon the wall of the pulp chamber, a considerable process of almost any conceivable form may grow out into the pulp tissue. These are very generally clear calcifications, but sometimes they show a confused dentin formation with the dentinal tubules twisted among each other in vague and indefinite forms.



FIG. 1574.



FIG. 1575.

FIGS. 1574, 1575. Teeth from the same mouth, showing erosion which had cut so nearly through one that part of the crown had broken off. In both the former position of the pulp chamber had been cut through, but had been previously filled with secondary dentin and the pulps were not exposed.

ETIOLOGY. These calcifications occur under many conditions, most of which are abnormal. They occur oftenest, and can be regularly found in cases of abrasion and of erosion, and it is in these that their causation and general history may be best studied, because they present a large variety of specimens, from those which are just beginning to those which have made wide progress. Figures 1574 and 1575 are of teeth which had been cut through the position of the pulp chambers by erosion.

Figures 1576, 1577 and 1578 illustrate the building of secondary dentin in cases of abrasion. In figure 1576 the incisal portion of the former pulp chamber was completely filled with secondary dentin, which had been worn away evenly with the original dentin as the abrasion progressed.

Something of the same character of secondary dentin occurs as a result of dental caries, if the decay involves a considerable number of teeth and progresses slowly, keeping the fibrels more or less exposed to irritation. If caries progresses with what may be called normal rapidity, generally no deposit of secondary dentin will occur. Hence, in preparing cavities for restorations, there will be no secondary dentin protecting the pulp.

Figure 1580 is a rather unusual case showing a very pronounced building of secondary dentin as a result of the irritation resulting from the involvement of the dentin by slowly progressive caries. It will be noticed that the decay had made very little progress within the dentin, yet the secondary dentin corresponds very exactly to the tubules involved. The directions of the tubules may be clearly seen.

DIAGNOSIS. The diagnosis may be made with the radiograph, only insofar as the radiograph will show that the pulp chamber and root canals are more reduced than normal for the age. One

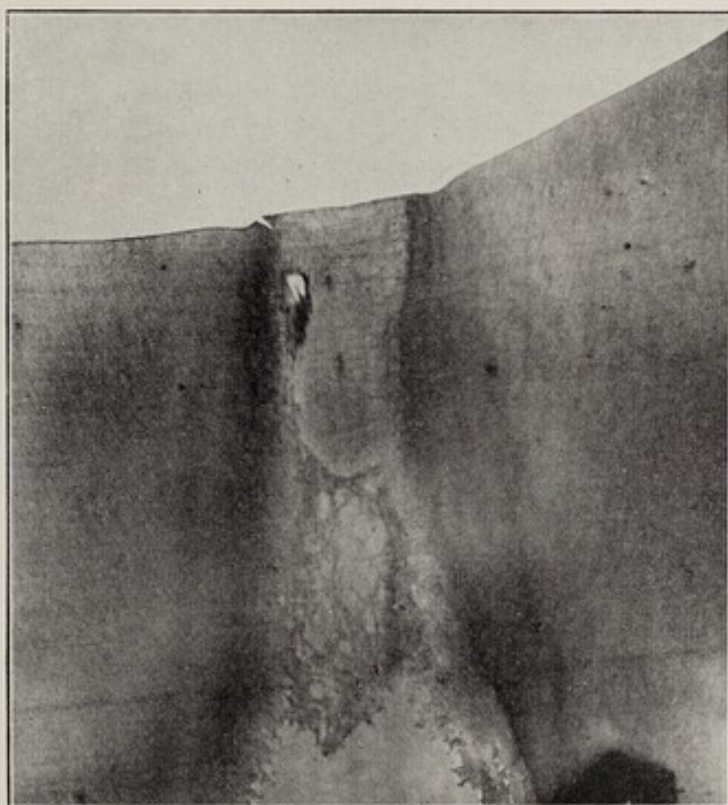


FIG. 1576. Secondary dentin in case of extensive abrasion. The position of the former pulp chamber has been reached by the wear, but it had been previously closed over by the building of secondary dentin.

may judge from the condition of the teeth, as to abrasion and erosion, that secondary dentin has been deposited. In addition, the lack of sensitiveness of the dentin indicates a deposit of non-tubular dentin.

PROTECTION FOR PULP. The physiological import would seem to be that the growth of secondary dentin is a response to irritation of the dentinal fibres, and has a definite intention of placing the soft tissues of the pulp farther from the source of injury, and thus protecting it. From any viewpoint whatsoever, this idea stands out prominently. For instance, when a tooth that has a number of facets worn into the dentin in cup shapes in the position of the

cusps, and particularly in those cases in which the patient has had much pain from these in biting hard substances, because of the sensitiveness of the exposed dentin, it is a definite indication that the growth of this secondary dentin is starting.

CALCIFICATION MORE EXTENSIVE AS ABRASION OR EROSION PROGRESSES. The secondary dentin becomes more extensive as the abrasion or the erosion progresses, and finally in cases in which most of the crown of the tooth has been worn away, or the erosion has cut deep into the dentin, a calcific deposit may be seen in the position previously occupied by the pulp. This is different in color from the dentin surrounding it; usually it is a clear calcification.

SECONDARY DENTIN OFTEN DEPOSITED THROUGH REFLEX ACTION. The most general idea expressed in the literature has been that this secondary dentin is a local formation, confined mostly to the



FIG. 1577.



FIG. 1578.



FIG. 1580.

FIG. 1577. A central incisor showing extensive abrasion. The pulp is all calcified except a mere shred that shows as a white line.

FIG. 1578. A central incisor, the greater part of the crown of which is worn away. The pulp is completely calcified far into the root.

FIG. 1580. A small building of secondary dentin, evidently caused by the decay on the surface.

protection of the pulp over the area which is threatened by the injury to the dentinal fibrils. Extensive examinations show that the formation occurs reflexly from an impression made upon nerve centers by the irritation of the dentinal fibrils. This effect is general to the teeth of the person, and not localized to individual teeth; although it may be localized over the regions of the pulp especially threatened by the irritation of its fibrils. That is to say, it is not necessarily confined to local parts of the individual pulp chambers, nor to the teeth which have been worn, but may occur also in those teeth that may have escaped wear as a result of the previous loss of teeth of the opposite arch. Such teeth, though unworn, may show the calcification almost precisely the same as those which are worn.

In a case in which twelve teeth were extracted for one person, ten showed extensive abrasion and two molars were unworn for

the reason that the molars from the opposite jaw had been extracted many years before.

The secondary dentin had begun as a fairly regular formation, upon the previously existing dentin in the same way and to the same extent, in the teeth which were unworn as in the abraded teeth. In the teeth which were worn, the pulp chambers, even in the molars, had been completely obliterated and mostly worn away. The pulp chambers of the unworn teeth were obliterated in the same way, showing that the effect was not local to the teeth worn, but involved all the teeth of the person. This is the general rule in all of these extensive calcifications of the pulp.

In teeth in which the formation has not been so extensive, the beginning on the floor of the pulp chamber will be the same as that upon the occlusal wall of the pulp chamber; the calcification is likely to occur upon all the walls of the pulp chamber at the same time. This could not be so if the calcification had been



FIG. 1581. Atrophy of the odontoblasts: a, Odontoblasts that have taken the stain in an irregular manner. There is also a peculiar variation in their size. Some vacuolations appear in the tissue.

confined to the region of the pulpal ends of the dentinal fibrils surface of the tooth; or erosion proceeding from the labial or buccal surface.

THE EFFECT UPON THE DENTIN AND ENAMEL. The effect upon the dentin of cutting off the fibrils from the pulp is to progressively destroy the vitality of the fibers as the tubules become exposed. The secondary dentin may grow and narrow the pulp chamber without affecting the dentinal fibrils, but when the dentinal fibrils are no longer formed, and a clear calcification begins, the fibrils in the dentin die. Those tubules which are exposed to the saliva become filled with the materials of decomposition which occur in the mouth, and in time the whole of this superficial portion of dentin becomes softer than normal. It can be cut without pain to the patient, though the line of demarcation as to pain is in many of the cases much broader than the exposure of the ends of the tubules would indicate.

The softening of the dentin renders the enamel much more liable to break away from it than from healthy dentin. This is a matter to be reckoned with in operative procedures. This is different in color from the dentin surrounding it; usually it is a clearer variety of calcification. The abraded dentin becomes darker than normal, causing the clear calcification to stand out more prominently in cases in which the wear has involved the positions of the former pulp chamber. Examinations of teeth in the mouth will show that this region of dentin has lost its sensitiveness, while beyond the darker dentin, there may be dentin of normal color, which exhibits normal sensitiveness. See Figure 1576.

EXPOSURE OF PULP BY ABRASION AND EROSION. In the beginning these calcifications act as a protection against the exposure of the pulp by abrasion or by erosion. Very rarely have erosions progressed rapidly enough to expose the pulp. They may cut a tooth in two, allowing its crown to drop away, but before the pulp



FIG. 1583.

FIG. 1583. Pulp nodule.



FIG. 1584.

FIG. 1584. Radiograph showing nodules in pulp chamber.

chamber is reached, the pulp will have been protected by a growth of secondary dentin, and the cutting proceeds through this secondary growth in removing the crown of the tooth. See Figures 1574 and 1575.

Exposure of the pulp results more frequently from abrasion of the teeth, than by erosion. Generally this exposure in abrasion will be of the tips of the horns of the pulp, arousing first the symptoms of hyperemia, followed by those of inflammation. This generally occurs in cases in which the horns of the pulp are unusually long, and the abrasion beginning upon the cusps exposes them. In these cases one may not be able to see an exposure of the pulp, but by taking a very fine broach and placing the point successively about the central part of the abrasion, where the horn of the pulp should be, the point is likely to drop into a very fine opening, which reveals the exposure.

The effect upon the dental pulp deepens as the accumulation of secondary dentin within the pulp chamber increases. Many of

the cellular elements disappear, or become mere threads, and microscopic examination indicates that the tissue has become more distinctly fibrous until its structure is greatly changed. When calcifications have made considerable extensions upon the walls of the pulp chamber, narrowing it, there is a marked effect produced upon the pulp tissue. The cells of the pulp dwindle in size, and as the deposit becomes clear the odontoblasts disappear, and the pulp tissue simply lies against the growing clear calcification without the interposition of the odontoblastic layer. See Figures 1581 and 1573. As the change to non-tubular structure occurs, the pulp usually becomes insensitive and fails entirely to respond to temperature changes. The condition is a more or less complete loss of function by the pulp. See Figures 1577 and 1578. Finally death of the remaining portions of the pulp occurs.

This is true of all kinds of calcifications which materially fill up the pulp chamber. A few calcifications scattered through the mass of the pulp tissue do not seem to produce this effect. In this consideration it seems that the only difference in effect between

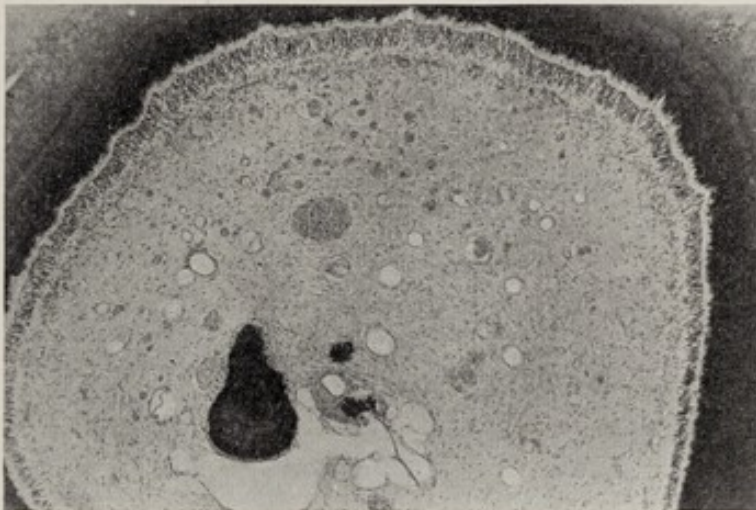


FIG. 1585. Three small pulp nodules.

the calcifications beginning as clear calcifications, and those that begin as secondary dentin proper, is found in the suddenness of the interposition of clear calcifications to prevent the communication of the living pulp with the fibrils of the dentin.

Thus in the beginning, the effect produced by these calcifications is to protect the pulp for the time from exposure by extensive wear, or other injurious processes going on, which keep the fibrils in a state of irritation. This effect is beneficial, as it gives a nearly normal usefulness of the teeth for a much longer time than could otherwise occur. It also greatly lessens the chance of early inflammation and death of the pulp.

On the other hand, the amount of pulp tissue left in the root portion of the pulp chamber has become very small in most of

these cases. The apical foramen is also reduced to the narrowest limits, yet it seems never to be entirely closed.

DANGER OF PERIAPICAL ABSCESS. In these cases the conditions for the production of periapical abscess would seem to be reduced to the minimum by the small amount of tissue composing the dead pulp, and the extreme narrowing of the apical foramen. There is a further consideration, that in the majority of these cases there is no infection introduced through an exposure of the pulp. This gives a fair assurance of continued health to the parts. The formation of periapical abscess is not common in these cases.

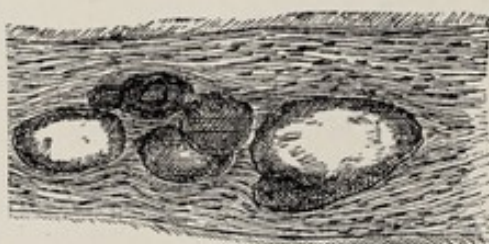


FIG. 1586.

FIG. 1586. Pulp nodules in the canal portion of the pulp.

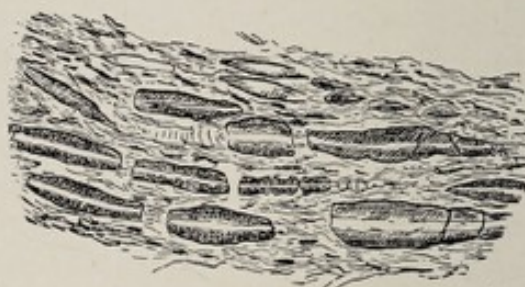


FIG. 1587.

FIG. 1587. Drawing of cylindrical calcifications in root canal.

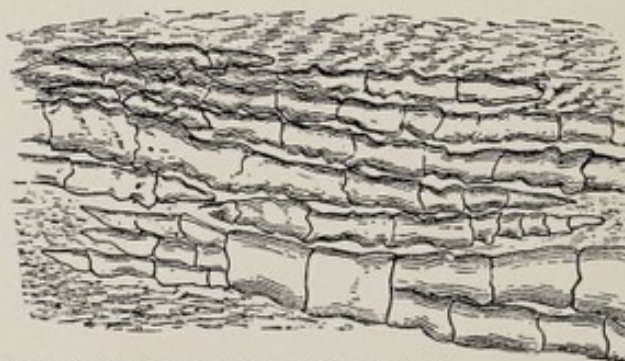


FIG. 1588. Cylindrical calcification, irregularly jointed.

CALCIFICATIONS GROWING FREE IN THE TISSUES OF THE PULP, UNATTACHED TO THE WALLS OF THE PULP CHAMBER.

VARIETY OF FORMS. These calcifications take a multitude of forms. The most common are the nodular formations in the bulb of the pulp ordinarily spoken of as pulp nodules or pulp stones.

Figure 1583 is a bucco-lingual section through a bicuspid showing a small nodule in the pulp chamber, while Figure 1584 is a reproduction of a radiograph in which the pulp chambers of the upper first and second molars contain nodules of about the same size. Figure 1585 is a transverse section of a pulp showing three small calcifications or denticles. This is also a very excellent illustration of the various cellular elements of the pulp. Figure 1586 shows several nodules in a root canal.

Next in frequency are the fusiform, or spindle-shaped, calcifications in the root portions of the pulp. In some cases the various calcifications in the root portions are joined together.

Figure 1587 shows a number of spindle-shaped calcifications in a root canal, while Figure 1588 illustrates a variety of jointed forms. Occasionally, all, or nearly all, of the tissue within the pulp chamber and root canals is found calcified, either in a single mass, or in several masses, more or less closely united.

Most of these calcifications are homogeneous or clear calcifications. They are all nontubular. They sometimes have threads of tissue which are not calcified, irregularly mingled in their substance. In some specimens there are many of these, in some very few, in others none. The physiological process of their growth seems not to have been made out.

Another very curious form is that in which the root portion is filled more or less completely with long spiculæ of hard formations which seem to be jointed, the ends resting loosely upon each other. These give a stiffened appearance to a pulp that is removed when in this condition, which has been called the lead-wire formation. Such a pulp seems stiff. It may be bent in any way and it will stay in whatever position it is bent, as would a piece of soft lead wire.

Pulp stones of conglomerate character may fill the entire bulbous portion of the pulp of a molar tooth without having any attachment whatever to the walls of that cavity.

GENERALLY NO SYMPTOMS. There are some writings which represent efforts to make a diagnosis of the presence of these clear calcifications. Many have had the idea that the growth of these bodies was productive of some of the obscure pain found in regions about the mouth. All of the available evidence points to the fact that none of the various calcifications causes pain, although such cases are occasionally reported.

Treatment of the Dental Pulp

BIBLIOGRAPHY ON THE DENTAL PULP PAGE 411

ILLUSTRATIONS: FIGURES 1601-1680.

Conservation of the Dental Pulp

FEW practitioners realize the advance that has been made in recent years in preventive treatment as applied to the dental pulp. The development of knowledge of focal infections, and the use of the radiograph have been the principal factors, although greater consideration for the pulp in all operative procedures, better practice management and its associated better control of dental caries, have all contributed.

A summary of a tabulation of pulps removed by the author during his period of practice will serve to impress the degree of success that has been attained in the conservation of the pulp by many dentists who have paid particular attention to the preventive phases of practice and have had few transient patients.

The following is a statement of the *average number per year* of pulps removed during *each five year period* from 1901 to 1935, inclusive.

Five year period	Average number of pulps removed per year	Average number of operating hours per year
1901-05.....	81	1166
1906-10.....	70	1297
1911-15.....	71	1400
1916-20.....	52	1439
1921-25.....	31	1511
1926-30.....	21	1017
1931-35.....	19	1030

This is a reduction of 76.3% for 1931-35 as compared with 1901-05. During each of two of the last ten years, the number of pulps treated was 13. These figures should be related to the annual average of operating hours for each period, as entered in the last column.

It should be said that the reductions are largely due: (1) to the change in practice of removing pulps from practically all teeth to be crowned, which was the vogue previous to advent of special studies of focal infections; (2) to discontinuance of treatment of the large majority of teeth with rarefied regions about their apices, which was possible after the radiograph became available; (3) greater regard for the conservation of the pulp in the preparation

of cavities for restorations and crowns and the more extensive use of nonconductors.

The conservation of the dental pulp is the first step in the prevention of all of the conditions which occur as sequelae of the death of the pulp. Such a program is naturally a part of that for the better control of dental caries. The main points in such a program as applied to the pulp are presented in the following paragraphs:

THOROUGH AND FREQUENT EXAMINATIONS. Involvement of the pulp by caries may be prevented in proportion as cavities are discovered and cared for before they become deep. The technic for making examinations for the early discovery of caries is given in detail in Volume I, page 31. Records of practitioners who have carried out a program of treatment similar to that presented in Volume III, page 2, are finding that a very large percentage of children are reaching adult life without the loss of a pulp.

GREATER CARE IN DENTAL OPERATIONS. In reviewing the various causes of hyperemia of the pulp which have been mentioned, it will be recognized that many cases may be prevented by greater care in dental operations.

In cavity preparation, the utmost care should be taken, not only to avoid exposing the pulp, but to avoid near approach to the pulp chamber, or to the recessional lines of the pulpal horns. The dentin grows from the dento-enamel junction inward, and the pulp recedes and becomes smaller as the dentin is formed. The lines along which the horns of the pulp recede as the dentin is gradually formed are called the *recessional lines of the pulpal horns*. Oftentimes a horn of a pulp will persist as a slender thread of pulp tissue reaching far toward the dento-enamel junction, even when the pulp chamber has become quite small. A very large percentage of the accidental exposures of the pulp in cavity preparation are exposures of the horns of the pulp. Therefore, it is especially important that these lines be avoided in preparing cavities. They are described in Volume II, page 134.

A pulp is in danger of death from thermal shock subsequent to the placing of a restoration, if the cavity be cut deeply enough to closely approach the pulp chamber or horns of the pulp at any single point, or if much of the cavity be cut only fairly deep. In other words, a pulp might die from thermal shock from a metal restoration placed in a small deep cavity, or from a very broad, but comparatively shallow cavity. There would be much more danger of thermal shock from a mesio-disto-occlusal restoration of moderate depth than from a simple occlusal restoration of the same depth, because the mesio-disto-occlusal restoration would be in contact with the dentinal tubules on three sides of the pulp and sudden changes of temperature would produce greater shock. A careful review of the cavity forms will show that they are planned to give the best possible resistance and retention forms, and at

the same time avoid near approach to the pulp chamber and the recession lines of pulpal horns. Naturally, no cavity should be cut deeper in the dentin than is required for retention.

USE OF NONCONDUCTORS. In every case in which it is necessary, either in the removal of caries, or in securing proper cavity form, to cut deeply enough to endanger the life of the pulp from thermal shock, a nonconductor should be placed to prevent thermal shock from the restoration. In some cases, particularly to cover axial walls of incisor proximal cavities, a piece of quill, cut from a quill toothpick, may be used. This is cut to lie against the axial wall and is held in place until one or two pieces of gold have been condensed, overlapping a margin of the quill. A thin layer of oxyphosphate of zinc cement may be generally used as a nonconductor. This may be conveniently placed by cutting a piece of stiff writing-paper to fit the cavity, and after putting the necessary amount of cement on this, it should be carried to the cavity with the cement next to the dentin wall to be covered, and gentle pressure made on the paper until the cement is spread out into a thin layer. This may conveniently be done with inlays by trimming away a portion of the wax pattern, or grinding away a sufficient thickness of gold from the cavity side of the inlay to provide space for a considerable thickness of cement. An application of Hartman's solution, or one of the several cavity varnishes, just before placing cement as a nonconductor or immediately before the inlay is set, will generally prevent the pain often caused by the cement. Every precaution should be taken to avoid the creation of heat or undue pulp irritation in all operating. Attention has already been called to the danger in the use of disks, stones, etc.

TREATMENT OF HYPEREMIA.

In cases in which there is evidence of hyperemia which has developed as a result of excessive changes of temperature, the patient should be urged to use the greatest care to avoid hot or cold drinks, hot or cold food, or breathing cold air through the mouth. If these are rigorously avoided for a few days, the milder hyperemias will disappear as the rule. If the patient is one who must be out of doors in cold weather, the sensitive teeth may be protected by a covering of gutta-percha or modeling compound, molded to fit closely, but which may be removed and replaced by the patient at meal time. Some patients will make use of such an appliance, others will be so much irritated by it, that they will not keep it in the mouth. In some cases the exposed portion of the tooth may be partially or entirely covered with cement. If it happens to be a molar tooth, copper cement may be used, and it should be placed on the occlusal surfaces of the other molars of the same arch on both sides to relieve the occlusion on the hyperemic tooth. If these precautions are not taken, the condition is likely to grow progressively worse. The paroxysms of pain will become more frequent, they will be excited by a less

degree of temperature change, and the duration of the paroxysms will gradually increase. Finally the pulp will die.

The tooth may be so sensitive to temperature changes that water three degrees off the temperature of the body, either too hot or too cold, will excite a severe paroxysm of pain. These cases will recover, as a rule, if the utmost care is exercised to avoid temperature changes which produce pain. If paroxysms can be avoided by keeping the tooth at even temperature of the body, there is a good opportunity for recovery.

If the hyperemia follows the placing of a large gold inlay, it may often be brought under control by drilling a hole about 2 mm. in diameter directly through the occlusal surface of the restoration and placing a treatment of eugenol. The hole may be enlarged slightly when the cement is reached by carrying the bur around the hole with pressure on the side blades. After being certain that all of the cement is removed to expose as much dentin as possible, the medicament should be sealed in with gutta-percha. It may be advantageous to change this treatment once a week for several weeks.

When a patient presents with a hyperemic tooth, it is a good rule for the dentist to emphasize the fact that one of two things will probably occur; either the pulp will very gradually recover, or the paroxysms may become worse and then the tooth may rather suddenly be entirely free from pain. The patient should be warned that if the latter occurs, the probability is that the pulp has died, and there is the danger that an abscess will develop unless the dead pulp is promptly removed. In any event the dentist should, if possible, have the patient return at stated intervals, in order that he may have definite knowledge of the progress of the case.

CAPPING EXPOSURES OF THE DENTAL PULP.

In the majority of cases, efforts to save exposed pulps by capping are not successful, and the operation should not be undertaken, except under the most favorable circumstances.

INDICATIONS FOR CAPPING. It seems desirable to cap a pulp when it is exposed during the childhood period, while the apical foramen is still large, whether the exposure is caused by caries or is made in excavating, and during the adult period only when the exposure is slight and is made with a hand excavator. No attempt should be made to cap a pulp in a tooth with a fully developed root if it is exposed by caries, nor under any circumstances if the exposure is made by a bur.

One can usually determine by radiographic examination whether the apex of the root is still sufficiently wide open; the apical opening should be in the form of a funnel.

TIME OF COMPLETE CALCIFICATION OF THE ROOTS OF THE VARIOUS TEETH. The average time of the sufficient narrowing of the apical foramen for root filling in the various teeth, with something of the variations which occur in this process, is shown in Figure 1601. Cases will be found, however, in which the roots of teeth should not be filled so early as the ages mentioned, and this should always be determined by examination of the individual case. It is the habit of many dentists to attempt to fill the roots of teeth of children at too early an age, and generally with disastrous results.

TECHNIC OF CAPPING. If the effort is to be made to save an exposed pulp, the aim should be to avoid as much as possible any further irritation. The rubber dam should be in place. If there

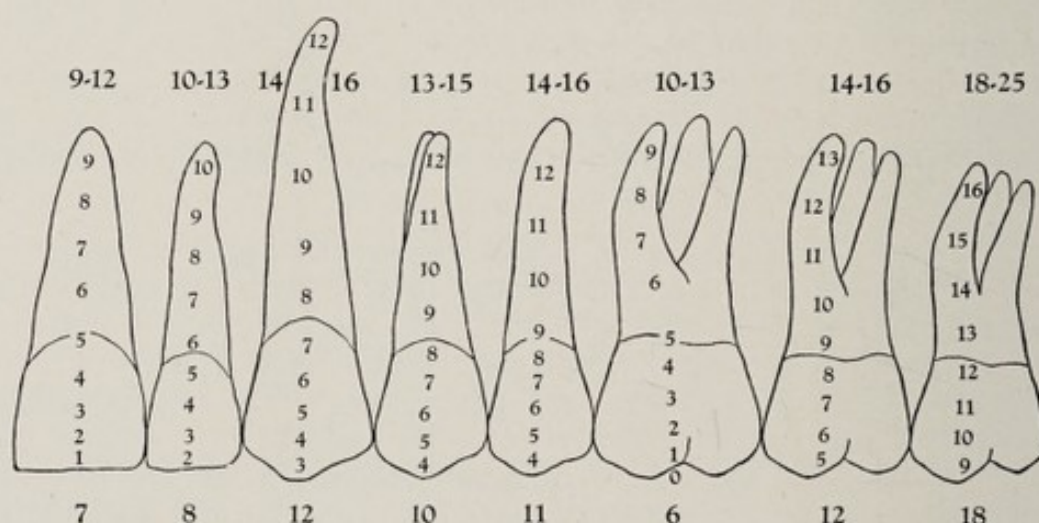


FIG. 1601. Calcification of the permanent teeth. The figures on the several teeth give the average calcification in years; the figures above each tooth give the ages between which the root is usually fully formed; the figure below each tooth is the average age of eruption.

be any hemorrhage, the blood should be absorbed with cotton. The immediate area should then be slightly moistened with a very mild antiseptic, such as eugenol or "1-2-3." The dentin about the exposure should be dried with cotton. Then, if the shape of the cavity will permit, a very thin wafer of pink base-plate gutta-percha, slightly moistened with eucalyptol, should be placed over the exposure. The eucalyptol will render the gutta-percha sufficiently sticky, so that it will adhere to the dentin. Then a small piece of stiff writing-paper should be cut so that it may be laid in the cavity over the gutta-percha. When this is ready, a mixture of oxyphosphate of zinc cement should be made and a small globule placed on the piece of paper. The paper should then be carried to the cavity and placed with the cement side over the gutta-percha, making gentle pressure on the paper to flatten the cement into a thin layer. If the cavity is too small to permit the use of the wafer of gutta-percha, this may be omitted and the capping made by placing the cement directly over the exposure, using very gentle pressure to avoid forcing the cement into the pulp chamber.

After the cement is thoroughly hard, a temporary filling should be placed, leaving the paper over the cement capping in order that there will be no danger of removing the capping when the temporary filling is removed. In all such cases, tests should be made at frequent intervals to know the condition of the pulp. Permanent restorations should usually be postponed until the formation of the root is certainly completed, or for six months or more in cases in which cappings have been made in adult teeth.

Technic of Pulp Treatment

GENERAL CONSIDERATIONS.

There are certain general propositions which are common to almost all operations which involve the opening and treatment of pulp chambers and root canals. These will be presented first. In this connection, the dentist should hold foremost in mind the fact that the tissue of the pulp can not be considered as separate and apart from the other tissues of the body; that, in the matter of transmission of infection, the pulp bears the same relation to the general system as do other tissues. Therefore, in the treatment of the pulp, surgical cleanliness is quite as important as in the treatment of other parts. The field of operating should have the same consideration as to asepsis; all broaches, other instruments and dressings should be sterile; the dentist has no more license to use an unsterile broach than has a surgeon to deliberately operate with an infected knife. The far-reaching, serious and sometimes fatal consequences of infections entering the system through root canals demand that patients be given the same protection which they receive at the hands of the surgeon. The technic for asepsis which will be presented is simple; it may be easily carried out to the last detail by every practitioner.

The treatment of a pulp should always be undertaken with a full appreciation of the fact that the continued usefulness of the tooth is dependent upon the success of the effort. Thoroughness in this class of operations is absolutely essential to success. A good knowledge of the anatomy of the teeth and a large store of patience are necessary to thoroughness. If there is a single class of operations in dentistry which deserves the most conscientious efforts of which each operator is capable, it is the treatment of root canals. The knowledge that an improperly treated canal may not give serious trouble for many years has doubtless led to much carelessness in this operation.

Thoroughness in root canal treatment requires time. It often requires that the operator be in the best possible physical and mental condition. While one may not always be able to control the time of doing these things, they should generally be set for the

first morning appointments, particularly for the final inspection of the canals and the placing of root fillings. Whenever the operator is uncertain of the conditions within the canal, either as to the removal of the last remnant of pulp tissue, or the probability of getting a filling well to the apex, a dressing should be sealed in and the patient given another appointment. Particular attention is called to the tabulation of good and poor root fillings in relation to the occurrence of alveolar abscess at the beginning of this chapter.

ASEPSIS. In the treatment of the pulp the field of operation should be treated as though it were a surgical wound. The immediate neighborhood should be maintained in an aseptic condition during each operation. Nothing carrying infection should be permitted to enter this field. All instruments and dressings should be unquestionably sterile. In no case should saliva be allowed to enter a pulp chamber from the beginning of the first treatment until after the root canals are filled. This may be done by so simple a technic that there is no reason why it should not be carried out to the finest detail, except in a very limited number of cases which present unusual difficulties.

PLAN FOR ASEPTIC TECHNIC. It should be recognized that it is impractical, although not impossible, for the dentist to keep his hands surgically clean during pulp treatments. However, a safe technic may be employed by which ordinary cleanliness of the hands will be sufficient in most cases. In other words, a plan may be carried out by which the operator's fingers will not touch anything which actually enters the pulp canal, or the aseptic field. Under this plan, asepsis in pulp treatment requires: (1) That the rubber dam be applied for every treatment, and in such manner that there will be no leakage of saliva; (2) that the field of operation — all teeth included in the rubber, and the adjacent rubber — be rendered sterile by swabbing with an antiseptic before the pulp chamber is opened; (3) that all broaches, burs, excavators and dressings which enter the pulp chamber shall be sterile; (4) that the pulp chamber be securely sealed before the rubber dam is removed.

APPLICATION OF THE RUBBER DAM. It would seem that no argument should be required to convince any thoughtful person of the absolute necessity of applying the rubber dam for the purpose of maintaining asepsis while a pulp chamber is open. It is just as important that the rubber be applied in cases presenting with the pulp dead and the pulp chamber widely open, as in cases in which the pulp is not exposed. The fact that the pulp tissue is already infected is not a reason for omitting to apply the dam. There is the same danger in treating such a tooth without applying the rubber dam and following rigid rules of asepsis as there would be if a surgeon should use unsterile instruments and dressings in an infected wound. As will be pointed out later, many chronic periapical abscesses are caused by failures to observe the

rule relative to the application of the rubber dam. The rubber dam should remain in place at each sitting until after the cavity in the tooth has been securely sealed.

STERILIZATION OF FIELD. After the rubber is in place, the field of operation should be rendered sterile by swabbing the crowns of the teeth included in the rubber, also the adjacent rubber, with an antiseptic, such as 60 per cent alcohol or eugenol. This should be done on each occasion after the rubber dam is in place and before the pulp chamber is opened. If a temporary filling has been placed at a previous sitting, it should not be removed until the rubber is on and the field sterilized. If the cavity is a proximal one, a thin saw may be carried past the contact, thus trimming off

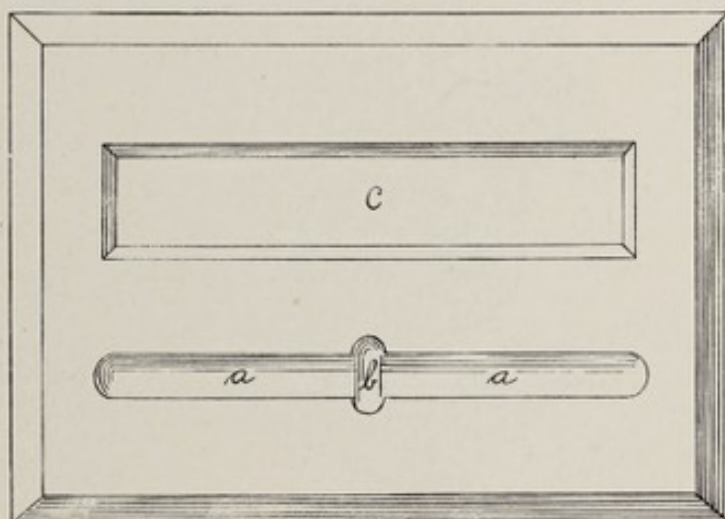


FIG. 1602. Glass slab for sterilizing broaches, etc.

enough of the temporary filling to permit the application of the rubber, without disturbing the filling.

STERILIZATION OF INSTRUMENTS, DRESSINGS, ETC. The thorough sterilization of all instruments entering the pulp chamber may be easily done by using two small dishes of suitable size, one containing 95% phenol, the other 60% alcohol. The accompanying illustration, Figure 1602, shows a special dish designed for this purpose, containing one depression the proper size for the immersion of a broach, bur, or other instrument, in phenol, and the other to hold a sufficient quantity of alcohol. The broach may be fully immersed in the phenol for a few minutes, then picked up with the pliers and washed in alcohol. After it has been placed in the broach holder, the end of the broach may be dipped into the phenol and washed in the alcohol as frequently as may be desired during the progress of the operation. Burs and excavators may be sterilized in the same manner. Gutta-percha points should also be immersed in the phenol and alcohol after they have been attached

to the root canal plugger. Sterile cotton pellets, bibulous paper points and gutta-percha points may be laid on the sterile towel on the tray or placed in small porcelain or glass dishes. After gutta-percha points have been attached to the ends of root canal pluggers, they should be immersed in the phenol and alcohol for resterilization.

INSTRUMENTS. The instruments required in pulp treatment are very few in addition to those used in cavity preparation. One should have at least six broach holders and an assortment of broaches of various sizes, two sharp steel probes, with points at slightly different angles, to be used in the location of the orifices

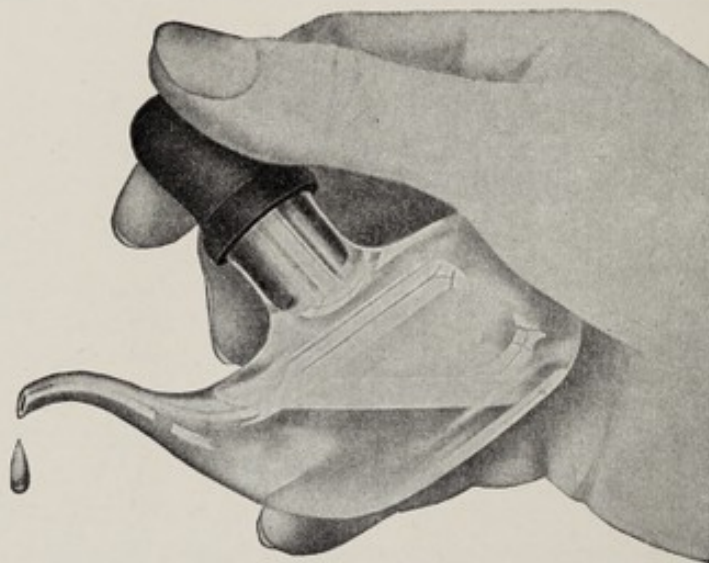


FIG. 1604. A very convenient dropper bottle. After the bottle is tipped forward, slight pressure on the bulb forces out a drop at a time.

to canals in bicuspid and molars, several sizes of fissure burs with the ends ground convex, pliers for handling bibulous paper points and cotton, dishes in which sterile cotton pellets, gutta-percha points and medicaments may be placed on the tray, also a special glass or porcelain dish for sterilizing broaches, burs, instrument points, gutta-percha points, and everything that enters the pulp chamber.

It is also very convenient and economical to have several dropper bottles, similar to that illustrated in Figure 1604, for medicaments to be used in the trays. These are available with either glass or rubber bulb stoppers. A glass stopper is necessary for eucalyptol.

STERILE BIBULOUS PAPER POINTS. The use of cotton in pulp and root canal treatment may be almost entirely dispensed with by the substitution of sterile bibulous paper points. However, these must be handled with the greatest care to prevent contamination. They should be kept in a sterile container, from which a few may be placed on the tray as needed.

The carrying out of these simple plans of asepsis presents no difficulties or delays, if the necessary equipment is at hand and conveniently arranged.

SURGICALLY CLEAN HANDS. Even with the equipment above, it may occasionally be necessary at the time of operating to use the fingers in wrapping cotton on a broach. For this, very small quantities of cotton may be placed in a small dish on the tray. This is the only procedure, in this plan of asepsis, that requires that the hands be surgically clean, and they should be scrubbed accordingly.

SEALING TREATMENTS. The material used for sealing treatments should be absolutely impervious to penetration by the fluids of the mouth; it should hermetically seal the cavity; it should be easy of manipulation; it should be sufficiently hard to withstand the stress of mastication without very much wear; it should be easily removable from the cavity when desired. Pure base-plate gutta-percha is the only material which meets these requirements. The so-called temporary stoppings contain so much wax that they are too soft to be dependable. Laboratory tests show that the oxyphosphate cements can not be generally relied upon as being impervious to moisture. This is shown by the number of teeth which discolor when cement is used as a sealing agent for a considerable time. Another objection to cement is the difficulty of removing it. If the cement has become thoroughly hard, it often requires much cutting with a bur. This is usually an unpleasant procedure for the patient, and may be very painful if the tooth is tender to pressure.

TECHNIC OF SEALING TREATMENTS WITH BASE-PLATE GUTTA-PERCHA. The technic of placing a filling of base-plate gutta-percha is simple, but the rules must be followed very exactly to insure success. It is essential in the first place that the cavity should be cut to reasonably good form for the retention of the gutta-percha filling. The pulp being involved, the cavity is necessarily of some depth and it will usually require very little additional cutting to give sufficiently good retention form.

The rubber dam should be on and the cavity thoroughly dry. The walls should then be slightly moistened with a eucalyptol which will dissolve gutta-percha. This will soften the gutta-percha which comes in contact with the walls so that it will adhere. The gutta-percha should be warmed until it is quite soft and pliable. Care should be taken not to overheat it, as it will not again become as hard as it otherwise would. If the cavity is small, the filling may be made of a single piece, but for most cavities it will be best to use several small pieces, placing each one and packing it carefully with as large a flat-end instrument as can be used in the cavity. Amalgam pluggers are excellent for this purpose. The direction of the force should be toward the walls, the same as in condensing gold. Additional pieces should be added until the cavity is full. All of

the packing should be done with cold instruments. Then with a flat burnisher, heated sufficiently that it will readily cut the gutta-percha, the filling should be trimmed to form. The movements of the hot burnisher should generally be toward the margins. If the burnisher is not heated sufficiently, it will drag in the gutta-percha and loosen it. It must be hot enough so that it may be carried through the gutta-percha with a quick stroke. When the trimming is done in this way, the mass of gutta-percha will not be heated sufficiently to cause pain.

In proximo-occlusal cavities, the septal tissue should be protected by holding the blade of a finishing-knife, or other suitable instrument against the tooth at the position of the gingival wall. This will prevent the gutta-percha from being crowded against the soft tissue.

If, in the sealing of a treatment with gutta-percha, it is desired to avoid pressure, a piece of stiff writing-paper may be laid in the cavity and covered with a layer of cement, or a piece of sheet metal — copper, German silver or steel — may be placed first, and the gutta-percha sealing placed over it. When desired for appearance, a gutta-percha sealing may be placed within the cavity, without entirely filling it, and it may then be covered with cement or temporary stopping.

RATIONALE OF PULP AND ROOT CANAL MEDICATION.

Aside from the measures which may be taken to prevent diseases of the pulp, there is little that may be done in treatment which does not involve the removal of the pulp. Therefore, except in cases of hyperemia, treatment is generally undertaken with the idea of pulp removal and root filling, and certain objectives should be held prominently in mind: (1) To avoid pain as far as is possible; (2) to maintain strict asepsis; (3) to avoid injury to the tissues about the apex of the root either by infection through the root canal, by the medicines used, or by broaches passed through the apical foramen.

If the pulp is vital, the patient may present complaining of pain. This may be caused by pressure within the pulp chamber; or by an inflammation of the pulp tissue without pressure, the pulp chamber being exposed by a cavity in the tooth. In the former case the opening of the pulp chamber will relieve the congestion and reduce the pain, and the operations for the destruction and removal of the pulp may be undertaken at once. If the pain is caused principally by inflammation of the pulp, a medicament is indicated to reduce the inflammation, and nothing has proven more satisfactory

than eugenol or the "1-2-3"* preparation for this purpose. It is also important to protect such a pulp from thermal shock and it should at the same time be protected against infection. Therefore, the medicament should be sealed in, and should usually remain for a week.

When a pulp has been removed, the indication is for a medicament which will keep the root canal sterile. For this purpose any mild antiseptic may be used. In sealing medicaments in root canals, it should always be kept in mind that the drug may penetrate the apical foramen and come in contact with the tissues about the apex of the root. The rule should be that no drug which would seriously injure the soft tissues, if held in contact with them, should be sealed in a root canal. Therefore, such drugs as 95 per cent phenol, oil of cassia, or preparations containing formalin, which will injure the tissues, should never be sealed in root canals. Certainly no drug should be sealed in a root canal which would cause serious injury to soft tissue elsewhere, as the skin, when held in contact with it. The use of such drugs has, doubtless, so injured the apical tissues as to lead to the formation of a fair percentage of chronic periapical abscesses. During recent years the tendency has been to abandon the caustic drugs and use only those which may be placed in contact with the soft tissues without causing inflammation.

EXPERIMENTS WITH MEDICAMENTS USED IN PULP TREATMENT.
In a series of experiments† conducted by A. H. Peck to determine the antiseptic and irritating properties of various drugs used in root canal medication, it was shown very conclusively that many of the drugs then in use were definitely injurious to the tissues. The following statement regarding oil of cassia is quoted from Dr. Peck's report:

"As a test of the irritating properties of oil of cassia, a pellet of cotton was saturated with it and placed in a small rubber cup, to prevent evaporation. This was applied to the surface of the skin and held there by means of a piece of court-plaster large enough to cover it over and stick tightly to the surface of the skin about the edges. At the end of twenty-four hours a blister invariably forms; however, the inflammation in the tissues at this time is not very great. The blister will occupy an area from one-half to one-third greater than that to which the oil is directly applied, and will fill and refill with serum several times before any tendency to recover is noticed. At the end of forty-eight hours the inflammation in the parts involved is intense, and occupies an area four or five times as great as that to which the oil is directly applied."

* One part oil of cassia, two parts of phenol, three parts oil of gaultheria. The oils should be mixed, and melted crystals of phenol should be added. This makes a clear solution. If 95 per cent phenol be added, it will make a cloudy solution.

† The Essential Oils and Some Other Agents, Their Antiseptic Value, also Their Irritating or Nonirritating Properties, by A. H. Peck, in the Transactions Illinois State Dental Society, 1898, p. 154; Dental Review, Vol. XI, 1898, p. 593.

More recently, the late Dr. E. S. Willard, professor of bacteriology in Northwestern University Dental School, made a similar series of experiments, sealing three drops of each medicament for forty-eight hours on the forearms of members of the senior class, who volunteered for the purpose. Direct color photographs of six of the arms are reproduced in Figures 1605 to 1610, and six other photographs are reproduced in black and white in Figures 1611 to 1616. While other applications were made, those illustrated were selected as representing typical results. The drugs were applied to the epithelium of the skin and it is presumed that the inflammatory reaction would have been more marked had it been possible to make the applications directly to connective tissue.

Figures 1605 to 1610 are direct color photographic reproductions of portions of forearms upon which various antiseptics were sealed under rubber covers for forty-eight hours, to determine their effect upon the tissues. The technic used in making the applications is illustrated in Figure 1611. The photographs were taken immediately after the removal of the applications, which were placed on the arms of members of the class of 1915, Northwestern University Dental School.

Figure 1605 is of an arm to which beechwood creosote was applied. There was no discomfort, and when the drug was removed the skin appeared to be only very slightly stained. In view of the high antiseptic properties of this drug, it is recommended for the treatment of canals from which dead pulps have been partially or completely removed.

Figure 1606 is of an arm to which eugenol was applied.

Figure 1607 shows the inflammation caused by the application of oil of cinnamon.

Figure 1608 shows a very slight inflammation resulting from the application of "1-2-3," a preparation suggested by G. V. Black many years ago. There was one small blister when the drug was removed. It ranks very close to eugenol as a root canal dressing.

Figures 1609 and 1610 illustrate the surface appearance of the several inflammations caused by cresol and formalin. All of the arms to which this drug was applied were painful; one student removed the application after seven hours because of the pain. These two illustrations fairly represent the inflammation resulting from a forty-eight-hour application. The centers were yellow and looked as though the tissue would slough off, but it did not. Several months later, induration was still present and the dead tissue was being gradually thrown off in scab after scab. One arm continued to throw off an occasional scab over a period of eighteen months.

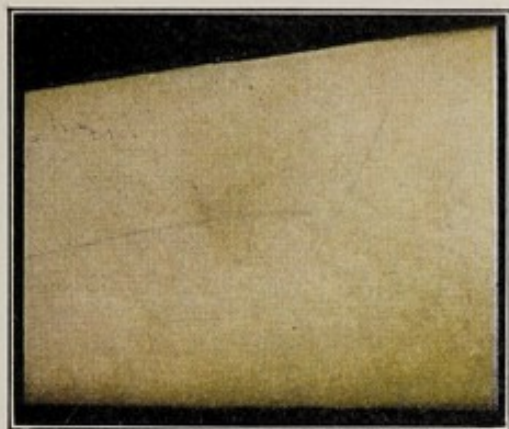


FIG. 1605. Beechwood Creosote.



FIG. 1606. Eugenol.



FIG. 1607. Oil of Cinnamon.



FIG. 1608. "1-2-3."



FIG. 1609. Cresol and Formalin.



FIG. 1610. Cresol and Formalin.

FIGS. 1605 to 1610. Color photographs of forearms on which various medicaments were sealed. See text.

Figure 1611 illustrates the technic of applying the various medicaments. A pellet of cotton was moistened with three drops of the drug and applied directly to the arm. This was covered by a piece of rubber dam and sealed with adhesive plaster. It was removed after forty-eight hours.

Figure 1612 is an ordinary photograph of the arm shown in Figure 1606, to which oil of cloves was applied. There was no appreciable inflammation.

Figure 1613 shows somewhat better than Figure 1607 the blister which formed as a result of the application of oil of cinnamon.

Figure 1614 shows the result of an application of oil of cassia. The area was brownish red and the inflammation sufficiently great to condemn this drug for root canal medication.

Figure 1615 and 1616 are from photographs of the same arms as shown in Figure 1609 and 1610, but were taken seven days later. Figure 1616 shows three pins which were pushed in 8 mm. (nearly $\frac{1}{3}$ of an inch) before any sensation was felt. This arm looked practically the same two months later.

Treatment of Pulps of the Temporary Teeth

There is perhaps nothing that can be considered as more important in the general management of a practice than the proper attention to the temporary teeth to prevent pulp exposures by caries. These teeth often begin to decay very early, and constant watchfulness, particularly for decays upon the proximal surfaces, is of paramount importance. If decays expose the pulps, it is difficult to handle these teeth successfully afterward.

The exposure may come at a time when it is impossible to make a good root filling. The root may not be fully formed or possibly resorption may have begun, so that the end of the canal can not be properly filled. The period during which the roots of the temporary teeth are full length is comparatively short, and this is the only time when really good root fillings may be made.

TIME OF COMPLETE CALCIFICATION AND BEGINNING RESORPTION OF ROOTS. The accompanying illustrations give about the average progress of calcification of the temporary teeth, also the average progress of resorption of the roots. There are numerous variations from these. See Figures 1617 and 1618. It will be noticed that the central and lateral incisors are both fully calcified during the second year, and that resorption of the root of the central begins about the fourth year, that of the lateral a year later. The roots of the cuspid and both molars are fully calcified by the end of the third year, or possibly three and a half years for the second molar, while resorption of the root of the cuspid does not begin until the eighth year, the first molar at seven and the second molar at eight. As a general



FIG. 1611. Application.



FIG. 1612. Eugenol.



FIG. 1613. Oil of cinnamon.



FIG. 1614. Oil of cassia.



FIG. 1615. Cresol and formalin.



FIG. 1616. Cresol and formalin.

FIGS. 1611 to 1616. Photographs of forearms on which various medicaments were sealed.
See text.

statement, there is the opportunity to properly fill the root of the central incisor when the child is between the ages of two and four, the root of the lateral incisor between the ages of two and five, of the cuspid between three and eight, the first molar between three and seven, the second molar between three and eight, because of the variations which occur in both calcification and resorption.

SERIOUS RESULTS OF EXPOSURES OF PULPS OF TEMPORARY TEETH. It often happens that exposure of the pulp of a temporary tooth will mean the premature loss of the tooth. This may lead to serious consequences by causing irregularities in the eruption of the permanent teeth. If, for example, the second temporary molar is lost in this way, there is nothing to prevent the first permanent molar from moving forward so that it laps over the space where the second bicuspid should come through. This condition, or some similar irregularity, is liable to occur as a result of the early extraction of any of the temporary molars.

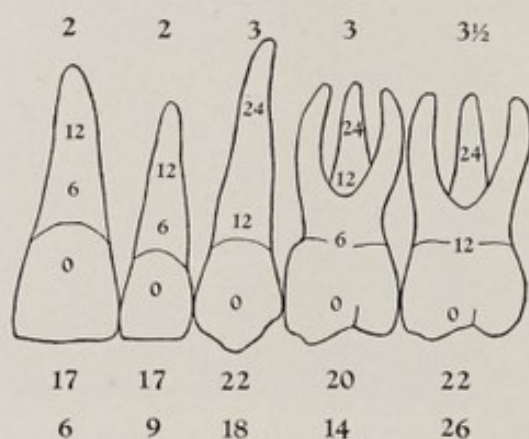


FIG. 1617.

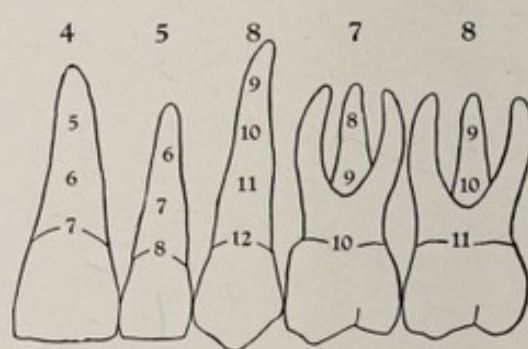


FIG. 1618.

FIG. 1617. Calcification of the temporary teeth. The figures below the teeth give the time of beginning calcification in weeks (foetal); the figures on the teeth give the average calcification in months from birth; the figure above each tooth gives the average age of completion of the root in years. The figures in the lowest row give the average time of eruption in months.

FIG. 1618. Resorption of roots of temporary teeth. The figure above each tooth gives the age of beginning resorption in years; the figure at the cemental line gives the average time of shedding.

A girl between thirteen and fourteen years old complained that there was something about her lower jaw that annoyed her, without there being any real pain. An examination showed that neither lower second bicuspid was in position, and that both first bicuspid were in their proper places, with the first molars inclined very far forward, occupying fully two-thirds of the spaces where the second bicuspid should be. They were one cusp too far mesially in relation to the upper teeth. The lower second temporary molars had been extracted because of alveolar abscess, according to the history she gave. This was before the days of the radiograph and a sharp, slender instrument was passed through the gum tissue on either side to locate the second bicuspid. The first permanent molars were moved distally, sufficiently to permit the eruption of the second bicuspid, and they were in their places in a few weeks.

The object of this recital is not to discuss the treatment of

such cases, but to impress the fact that such things can be prevented by very simple means if the decays are discovered before the vitality of the pulp is endangered. In this it should be remembered that the pulps of the temporary teeth are larger in proportion to the size of the teeth than in the permanent teeth, and the wall of dentin is correspondingly thinner, so that a depth of decay that would not be dangerous in a permanent tooth might be decidedly dangerous in a temporary tooth. Therefore, the watchfulness must be closer and more exacting than in the permanent teeth.

When the pulps of temporary teeth are exposed by caries, they usually die within a short time. A pulp may die and a periapical abscess may develop and pass into the chronic form with a sinus discharging through the gum, without much complaint from the child. In many of the cases, however, there is great pain accompanied by fever during the development of an acute periapical abscess, following the death of the pulp of a temporary tooth.



FIG. 1619.

FIG. 1619. Radiograph of lower jaw of boy twelve years old, showing roots of temporary second molar about cuspid crown.

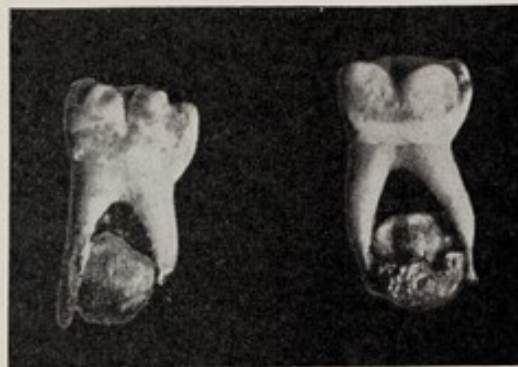


FIG. 1620.

FIG. 1620. Two temporary molars, which brought the bicuspid germs with them when they were extracted.

Occasionally, temporary molars will be retained beyond the normal time for shedding. If, for any reason, these teeth are to be extracted, it should be remembered that the germ of the forming bicuspid may be locked between the roots of the temporary molar, and will be in danger of being extracted with it. See Figures 1619 and 1620.

TECHNIC SAME AS FOR PERMANENT TEETH. If a case presents with the pulp exposed, but not yet dead, it may be treated along the same general lines as for the permanent teeth, which will be presented in the following pages. Eugenol may be sealed in for a week, when the pulp will usually be found to be dead, or so nearly so that it may be removed without causing much pain; or pressure anesthesia may be used.

The subsequent treatment, including the root filling, should be the same as for permanent teeth, for unless every detail is properly

carried out abscesses are likely to occur. The rubber dam should be in place and every precaution should be taken as to asepsis. In carrying out the treatment of these cases, everything should be prepared in advance so that the shortest possible time will be occupied in the operations. The dentist should have in mind distinctly that he is dealing with a child and often can not keep the child in the chair as long as may be necessary to do all that he might wish at one time. Therefore, he must make provision for cutting short the treatment before it is completed, placing quickly a dressing and a temporary filling, and dismissing the child until a subsequent day.



FIG. 1621.



FIG. 1622.



FIG. 1623.



FIG. 1624.

FIGS. 1621, 1622, 1623 and 1624. Root fillings in temporary molars.

Figure 1621 is a reproduction of a radiograph of a root filling in a lower second temporary molar for a girl not quite four years of age. It will be noted that the second bicuspid, which should be partly formed in the bone, is missing. Figure 1622 shows a root filling in the lower second temporary molar for a child four years of age, while Figure 1623 is from a root filling in the corresponding tooth for a child five years old, and Figure 1624 a similar root filling for a child of six years.*

PERIAPICAL ABSCESSSES OF TEMPORARY TEETH. Abscesses resulting from the death of pulps of the temporary teeth will often heal, following proper pulp treatment and root filling. In cases in which these abscesses can not be cured, the teeth should be extracted. Resorption of the root of a temporary tooth does not occur if there is a chronic abscess, as the activity of the resorption cells is not possible in the presence of the suppurative focus. Thus irregulari-

* These teeth were treated by students in the Children's Clinic at Northwestern University Dental School.

ties of the permanent teeth may be caused by the failure of resorption of the roots of abscessed temporary teeth, as discussed in Volume I, page 192.

The accompanying illustration, Figure 1625 shows one temporary upper incisor, the root of which has not been resorbed because of an abscess, while the roots of the other three incisors are almost entirely resorbed.

The treatment of the pulps of the temporary teeth has too often been neglected or has been done with too little care to be successful. Most dentists seem to have carried the teeth along with the least discomfort possible, not succeeding in making their treatment effective. Children are so difficult to handle that proper treatments are not attempted. Abscessed teeth are neglected so long as the child is free from pain; or if the child is suffering, nothing further than is necessary for temporary relief is undertaken. This middle course should not be followed. Every dentist should exert himself

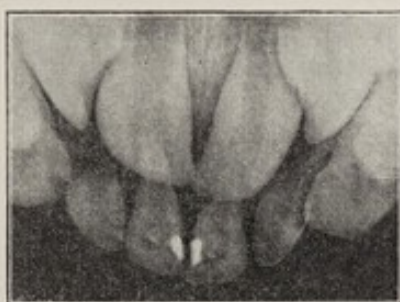


FIG. 1625. Radiograph of upper front teeth of boy seven years old. The right temporary central incisor was abscessed and resorption of the root had not occurred. The shadow of the root of this tooth may be seen overlapping that of the permanent central crown.

to carry through treatments of the temporary teeth to a really successful result or he should not undertake the treatment. The child's mouth should be kept free from infection, either by the most painstaking care of these teeth or by their extraction and the use of a stay appliance when indicated.

Treatment of Vital Dental Pulp

EXPOSURE OF THE DENTAL PULP. CONDITIONS PRESENTING. The pulp of a tooth (1) may be found exposed by caries in an open cavity, which has also exposed the pulp to the fluids of the mouth; (2) it may have been reached by the extension of caries but remain covered by a softened mass of carious dentin; (3) it may become exposed by accident during the preparation of a carious cavity.

The first and second cases are so similar that they may be considered together, only noticing differences of manipulation as they occur. In both, the supposition is that the pulp is to be destroyed and removed. In the first procedure, the problem is the preparation

of the cavity for the treatment of the exposed pulp, with the least pain and inconvenience to the patient.

OPENING THE CAVITY. The requirement is that the cavity be opened by the removal of all overhanging enamel and that the surrounding walls be freed from carious material, perfectly cleaned to solid dentin and cut to a form that will certainly retain a temporary filling for the purpose of sealing in applications that may be required in the treatment. It is not required here that the cavity be cut to the full outline form, as it will be prepared to receive the permanent restoration later, nor that the permanent anchorages be provided; but it is required that good and sufficient anchorage be made for a temporary gutta-percha filling against good, clean surrounding walls in every part. The cavity should be opened sufficiently wide to admit of the free and easy application of instruments for the exposure of the pulp. In doing this, especial care should be taken that the excavators be not directed toward the pulp of the tooth and that it be not interfered with in any way until after the carious dentin has been removed from the surrounding walls. This excavation should be done upon the principles laid down for the excavation of cavities in the class to which the case in hand belongs.

RUBBER DAM. It must be understood that the pulp is not to be exposed or the pulp chamber entered at any time, either primarily or secondarily, without the protection of the rubber dam. If the rubber dam has not been placed at the beginning, it should be placed after the cavity is well opened, and every preparation should be made for the best possible view of the deeper parts of the cavity. The field of operation should then be sterilized, and the carious material should be removed from the deeper parts of the cavity, and from about the exposure. In case the exposure is large and the pulp is already laid bare, the excavating need not be very perfectly done at first, the necessity being that applications can be laid directly upon the pulp tissue and perfectly sealed in place by a temporary filling. It must be done, however, before any part of the pulp is removed in order to be sure that no infectious material be carried from the cavity into the root canals.

MAKE EXPOSURE WITH BROAD INSTRUMENT. In case the pulp is covered with carious material only, this should be removed and the tissue of the pulp laid bare. In every case this should be done with the broadest cutting instrument that is applicable to the position, usually with the spoons. One should never undertake to remove softened material from over a pulp with an instrument so small that it is liable to pass through the opening into the pulp chamber, lacerate the pulp tissue, and inflict unnecessary pain. This should be taken as a principle controlling every procedure in this class of cases, and the operator should see to it particularly that the cavity be so opened and prepared that broad points may be used with facility.

IN BICUSPIDS AND MOLARS. When these preparations have been made, the best direction in which to make a sweeping cut having been determined, a spoon should be placed with its edge under the carious mass close against one of the walls of the cavity, and with a strong thrust in a curved direction it should be carried around the point of deepest penetration of caries to the other side, cutting at once to the full depth of the softened dentin, but avoiding actual exposure of the pulp. The position of the spoon for making such a cut is shown in Figure 1626. In this manipulation one should be able to remove all, or nearly all, of the carious dentin with very little, if any, pain. The dentin immediately over the pulp should be removed last, and it is usually possible, with a large sharp spoon to make a very slight exposure without pain of consequence, if the instrument is moved parallel to the surface along which the cut is made. The smallest spoon, also very sharp, may then be held nearly parallel to the surface of the dentin, and the edge may be carried laterally a little under the edge of the dentin at the point of exposure, which may be enlarged by a number of outward cuts. It is desirable that there be a sufficient exposure of the pulp to cause it to bleed a little, in order to relieve the congestion and assure the effectiveness of a sedative drug.

IN PROXIMAL CAVITIES IN INCISORS. In proximal cavities in the incisors, the largest spoons can not generally be used for want of room and it may be necessary to substitute those of smaller size, or the discoid. In these cavities the most desirable direction for the final cut for exposing the pulp is from the gingival toward the incisal. The penetration of the dentin by caries is apt to be long gingivo-incisally, and if the broad cutting edge can be placed at right angles to this, it is much safer against dropping into the pulp chamber and producing unnecessary pain. This position, or any angle closely proximating it, can often be obtained, and then the exposure is made with little or no pain. A discoid is really the best instrument for the purpose in this position.

MEDICATION TO REDUCE INFLAMMATION. If the patient has complained of previous pain, indicating considerable inflammation of the pulp, it will generally be best to seal in a dressing of eugenol, or a similar drug, for a week to allow time for the inflammation to subside, before proceeding with the removal of the pulp. If a pulp is very much inflamed, applications of cocain may be extremely painful, without producing anesthesia. By delaying, the pain may be avoided.

PRESSURE ANESTHESIA WITH COCAIN SOLUTION. In view of the fact that the pulp is to be removed as soon as it is anesthetized, the rubber dam should be placed first. The formula for the solution and the technic of its use in anesthetizing the pulp for painless cavity preparation are given in Volume III, page 69. The ideal situation is that in which the solution may be forced through normal dentinal tubules, or in which the pulp is already actually exposed, so that

the solution may be applied directly to the pulp. In a case in which the pulp is exposed by a proximal decay in a bicuspid or molar, the cavity should be filled with gutta-percha as soon as sufficient decay has been removed to permit. The gutta-percha may be packed against the proximating tooth for the moment to assure its stability. Then an opening should be made through the enamel of the occlusal surface in the most convenient position in a pit or fissure, which will necessarily be included in the occlusal outline of the cavity. A 1 mm. inverted cone bur should be used, revolving slowly. When the bur reaches the dentin, the patient should feel it. Then a new sharp bur should be used to deepen the cut about a half millimeter into the dentin. The opening in the enamel should be made slightly funnel shaped by enlarging the outer end during the withdrawal of the bur several times. A very small bit of cotton, rolled rather hard, should be moistened with the solution and placed in the depth of the hole. This should be covered with a small piece of unvulcanized rubber placed in the opening, and pressure should be made with a flat end instrument almost as large as the hole, so that the gutta-percha will act as a piston and force the solution through the dentinal tubules into the pulp. The pulp should be anesthetized at once.

When a separate opening may not be made through normal enamel, the bulk of the decay should be removed as thoroughly as possible, as previously described, until the pulp tissue is in view, except that the cavity walls should be prepared as nearly parallel as may be convenient, so that heavy pressure may be made on the rubber. If the patient has reported considerable pain, indicating a definite pulpitis, a sedative should be sealed in for a few days before attempting to anesthetize the pulp. A pellet of cotton, of convenient size in relation to the form of the cavity, should then be moistened with the solution and placed in contact with the pulp. It should be covered with a piece of unvulcanized rubber, and pressure should be applied very gradually until almost the full strength of the hand is used. The patient will often feel a sharp pain if pressure is applied too suddenly, and one may be guided by the patient's reaction in increasing the pressure. A second application may be necessary, but usually there is little difficulty in securing good anesthesia. The conditions must be such that the pressure is expended in forcing the solution into the pulp.

PROCAIN OR NITROUS OXIDE ANESTHESIA. Infiltration or conductive anesthesia with procain solution will be preferred by some operators. The choice between infiltration and conduction will depend upon the location of the tooth, infiltration being generally preferred in the upper jaw, conduction in the lower.

In a limited number of cases, in which the pain is severe and can not be controlled, the only practical procedure will be to remove the pulp at once, or to at least lacerate the pulp tissue sufficiently to produce a free hemorrhage. To do this, conduction anesthesia

with procain, or general anesthesia with nitrous oxide should be employed. If done without an anesthetic, the pain will be excruciating for an instant, although relief will follow almost immediately. If it be a molar tooth, a sufficient opening should be made to permit a spoon to be carried into and swept around the pulp chamber; in other teeth, good access having been secured, a broach may be used to engage the pulp and remove it.

THE USE OF ARSENIC TRIOXIDE. Arsenic has been used very infrequently for the destruction of the pulp in recent years, although occasional cases present in which it may be most convenient and the least painful. The use of arsenic was very largely abandoned along with other drugs which were known to be injurious to soft tissues, although, when properly used, there appears to be no damage to the periapical tissues from the arsenic. Arsenic trioxide will destroy tissue with which it is in contact, yet when it is applied to the coronal portion of the pulp, it apparently causes sufficient congestion of the arteries to compress the veins in the apical portion of the canal and the pulp dies of strangulation. This is shown by the fact that the pulp generally seems to be severed at the apex and comes away completely, in one piece. When there has been a prolonged low grade chronic inflammation, it may be impossible to satisfactorily anesthetize the pulp with pressure anesthesia and there may be difficulty in securing anesthesia by procain injection. In such cases, arsenic may be applied and will usually cause the death of the pulp within a few days. During recent years the author has used arsenic in such cases possibly once a year. A little lamp black should be added to the arsenic made up in ointment form, so that it is easily distinguished from the dentin.

The pulp should be fully exposed, and the cavity should be ready for the application to the pulp without further preparation. A piece of heavy writing paper or cardboard should be cut of such size and form that it may be easily laid in the cavity to cover the exposure. The walls of the cavity should be moistened with eucalyptol, or oil of cajuput, to prepare them for receiving a gutta-percha filling. Any excess of oil should be removed. A minute speck of arsenical paste may be placed upon the piece of paper and applied directly to the exposure, with the arsenical paste turned against the pulp. The paper should be pressed gently to place. As a rule, the arsenical application should remain for about forty-eight hours, although in the type of cases referred to it should be left for four or five days.

AVOID PRESSURE IN SEALING. A gutta-percha filling should be placed over the paper, using especial care not to make unnecessary pressure over the exposure of the pulp, as this might cause compression and pain. This gutta-percha filling should be as perfect in its adaptation to the cavity walls as it is possible to make it, in order that there may be no leakage of the arsenic. Unless the cavity is so shallow that there is lack of room, a further protection

of the pulp against pressure may be provided by cutting a second piece of paper or cardboard and fitting it over the first. Cement may be mixed rather thin and a globule placed over the paper, and allowed to harden, which will give opportunity for the use of any reasonable force in making the gutta-percha filling for sealing the cavity. In proximal cavities no overplus of gutta-percha should be allowed to impinge upon the gum septum, as has been mentioned.

After the temporary filling is completed, if there is a possibility that any of the arsenical preparation may have touched the surface of the tooth or adjacent soft tissues, these should be swabbed with cotton saturated with dialized iron, to counteract the injurious effect of the arsenic.

Occasionally, after the arsenic has remained in the tooth for forty-eight hours or longer, the pulp will be found only partly devitalized. The bulbous portion may be partially or completely removed, and a dressing of eugenol may be sealed in the cavity for a week, when the remainder of the pulp will be found to have died, as a result of the slight amount of arsenic which has been absorbed by it.

OPENING PULP CHAMBER PREPARATORY TO REMOVAL OF THE PULP.

When the pulp has been anesthetized, the rubber dam will generally have been placed first; if not, it should be in position and the field sterilized before the removal of the pulp is undertaken. In proximal cavities, in which the gutta-percha has been previously placed against the proximating tooth to seal a treatment, the filling should first be cut through with a fine saw, or trimmed away with a sharp finishing knife, in order that the rubber dam may be placed before the gutta-percha is removed. A single, quick cut with a hot flat burnisher will accomplish the same result. When the field is sterilized the gutta-percha filling may be softened by warming a burnisher and passing the end into it and holding it for a moment, when the gutta-percha may be lifted out.

Before any attempt is made to remove the pulp, the cavity should be cut away sufficiently to give good access to the canal or to each canal. The pulp should be tested with any convenient instrument, to be sure that it has lost its sensibility, for sometimes there is a failure in whatever method is used.

OCCLUSAL CAVITIES IN MOLARS. In the occlusal cavities in the molars in which the decay is large, often a hoe or spoon may be slipped into the opening, and the entire roof of the pulp chamber may be pulled away in several cuts, uncovering the pulp. But when the dentinal covering is strong, as is usually the case when the opening is only the exposure of one of the horns of the pulp, the better way is to enlarge the opening with a fissure bur. This

should be passed into the pulp chamber through the orifice of the exposure, and a cut may be made around the pulp chamber parallel with its axial walls and remove the covering in a single piece. Otherwise the opening may be enlarged by carrying the bur laterally toward the central portion of the covering of the chamber and then carrying it around in a circle. Then hoe 6-2-23 may be passed into the opening with its blade turned under the occlusal wall of the pulp chamber to determine the overhang and the cutting may be thus directed, until the whole extent of the chamber is uncovered. No overhang should be left at any point. In this cutting, the greatest care should be taken that the bur be not pressed into the floor of the chamber and its form marred. It is best to prepare a number of small fissure burs especially for this by grinding the ends smooth on a stone, so that they will not cut. With these there will be no danger of marring the floor of the pulp chamber. When the whole of the covering has been removed, it is generally best to enlarge somewhat toward the mesio-buccal angle in order to give better access to the mesio-buccal root canal. This may be done most readily and in the best form by a scraping movement with the cleoid excavator, or with the fissure bur.

In many cases, after the first opening has been made, the occlusal wall of the pulp chamber can be cut away more quickly with the chisel and mallet.

The case is now ready for the removal of the pulp. Incidentally much of the tissue of the bulb of the pulp, possibly all of it, will have been removed in doing this cutting, but no attempt should be made to remove the pulp from the canals until this cutting is satisfactorily completed and the cavity cleared of all dentin chips and cuttings. If this is neglected, it will often happen that some of these cuttings will get into the smaller root canals and stop them so that they can not again be opened. For this reason all cutting in opening the pulp chamber, especially in bicuspids and molars in which some of the canals are often very small, should be fully completed before any effort is made to remove the pulp from the canals. When in any case it is found that more cutting for access to some one root canal must be made, a bit of cotton should be placed loosely in the root canals that have been opened, to remain while the cutting is being done and until the cavity is again freed from cuttings. Then with the removal of this cotton the last of the cuttings will be removed.

PROXIMAL CAVITIES IN MOLARS. If the exposure is from a mesial cavity, the cutting will be, of course, to the distal and often will involve the removal of the middle third of the occlusal surface with the whole of the dentin intervening between it and the pulp. If a distal cavity, the middle third bucco-lingually of

the occlusal surface, with the intervening dentin, should at once be removed to a point well toward the mesial marginal ridge.

CAVITIES IN BICUSPIDS. In the bicuspid the exposures are almost uniformly from cavities in the proximal surfaces, and the pulp chambers are broad bucco-lingually. The cutting for opening the pulp chamber must be directed first to the central part of the crown, but later broadened from buccal to lingual; for the horns of the pulp when long are inclined toward the points of the cusps, as in Figure 1627. These horns should be fully opened so that they may be cleaned and solidly filled. The root canals in these teeth, especially in the upper first bicuspid, are given off from the extreme buccal and extreme lingual portions of the cham-

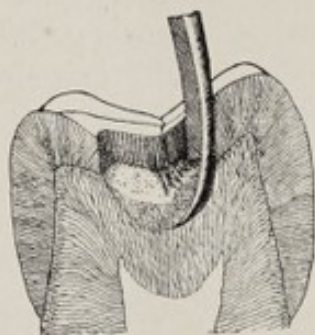


FIG. 1626.

FIG. 1626. Removing softened material with spoon 20-9-12. In this case this is done before squaring up the dentin walls because there is believed to be danger of exposing the pulp.



FIG. 1627.

FIG. 1627. A photograph of a second bicuspid split bucco-lingually to show the form of the pulp chamber. This patient was about fifteen years of age.

ber, as shown in Figure 1627, and unless the cutting is broad in these directions, the broach will not have direct entrance into them.

CAVITIES IN INCISORS AND CUSPIDS. In the incisors and cuspids, exposures are generally from proximal cavities. In opening these for the removal of the pulp, the orifice of the exposure should be first extended to the gingival wall of the cavity and to the full breadth of the chamber. The approach should be carefully considered. Generally a broach will not readily slide into the canal without being bent more or less. See Figure 1628. This is unfavorable, and a better approach must be made. When a cavity is so large that the pulp has been reached, the lingual wall should generally be cut away, and this will improve the approach, the instrument being passed to the lingual of the incisal edge of the tooth. The approach may be improved still more by taking a small fissure bur and, approaching the canal from the direction in which a broach would be introduced, passing it into the canal and cutting by lateral pressure, broaden the canal in

a direction to straighten the approach, as shown in Figure 1629. This cutting will be toward the disto-lingual if a distal cavity, or mesio-lingual if a mesial cavity, if the approach is to the lingual of the incisal edge. From whatever the direction of the approach, the cutting is to be so directed to the broadening of the incisal portion of the canal that the broach will reach the apex of the tooth with the least bending. A fissure bur with the end ground convex insures against injury to the sides of the pulp chamber.



FIG. 1628.



FIG. 1629.

FIG. 1628. An outline drawing of a central incisor, with an excavated cavity exposing the pulp, split mesio-distally to show the relations to the pulp chamber and canal to the cavity.

FIG. 1629. A fissure bur is entered into the opening into the pulp chamber and the canal enlarged, as shown, in such direction as to make the use of the broach easy.

REMOVAL OF THE PULP.

BROACHES. The instruments used for removing the pulp from the canals are the barbed broach and the smooth broach. Generally the barbed broach should be used first. Usually the bulb of the pulp will have been removed during the opening of the pulp chamber, and the broach selected should be suited in size to the canal. Each broach should be tested before using it by placing the end against the bottom of the sterilizing dish with sufficient pressure to bend it so that the point will be at a right angle to the handle, at the same time rotating the broach. It should bend in a regular curve. Occasionally in cutting the barbs, the shaft is cut too deeply at some point, which will cause it to break easily; such a broach should be discarded. The broach should generally be held in a light handle, but may be used without. The broach should be asepticized before it is used, preferably by immersing it in phenol for several minutes and then in alcohol.

After a broach has been used it should first be cleaned of all shreds of tissue by the use of a stiff brush. If a wire brush is

used for this purpose, the motions in cleaning should be from the point of the broach toward the handle, to avoid dulling the sharp barbs. The broach may then be immersed for a time in phenol, in a small bottle kept for the purpose. Upon removing the broach from the solution, it should be put away in a small glass bottle. Several bottles should be used for this purpose, so that the different sizes may be kept sorted.

It is the most satisfactory and economical plan to use at least one new broach for the removal of each pulp. Often several new ones should be used in molar teeth. This sharp broach will usually bring away practically the entire pulp at once, while a dull broach may bring only a part, thus increasing the difficulty of removing the remainder, and adding much to the time required for the operation. Used broaches may be employed for removing dressings previously placed, or for pulp removal, depending on the sharpness of the barbs.

TECHNIC OF REMOVAL. The broach should be passed into the canal, the point being directed against one of the walls so that it will pass in beside the pulp tissue rather than through it. Generally the point should be pushed to the apical foramen and then, if it is felt to be held tightly in the apical end of the canal, withdrawn until it is felt to be loose. The broach should then be rotated lightly, moving it slightly back and forth to be sure that the whole length is rotating and not being held in some curved part of the canal which would be liable to break the broach. The rotation should not exceed one turn. The broach should then be withdrawn. In a good many cases the entire contents of the canal will be brought away with the first effort. If not, the movement should be repeated. Sometimes the tissue of the pulp will break up into shreds and be but partially removed. In such cases, the smooth broach with cotton should be used.

After the removal of the pulp, a mild antiseptic, such as eugenol or "1-2-3," should be sealed in the canal. Bibulous paper points, moistened with the desired drug, should be placed in the canal. One end of the paper should project into the pulp chamber in order that it may readily be removed at another sitting. This may be covered with a pellet of cotton similarly treated and the cavity sealed with gutta-percha.

LOCATION OF CANALS IN UPPER MOLARS. Difficulty often occurs in finding the canals in the molar teeth. The difficulty is generally because the floor of the pulp chamber has been mutilated with burs and the openings of the canals filled with chips.

The floor of the pulp chamber is rounded or arched in the center and falls away toward the mouths of the canals. In upper molars, the canals are situated in the position of the angles of a triangle (the molar triangle), shown in Figures 1630 and 1631, the mesial line of which is the longest, the buccal the shortest, and the distal the intermediate length. For the first molar, this triangle

is well shown in the illustrations representing sections a little rootwise from the floor of the pulp chamber. This is best seen in the specimen itself; and the position and the direction of the canals, with relation to the walls of the pulp chamber and the main points of the surface of the crown, should be carefully studied.

The opening into the lingual root is the simplest and most direct. Generally, the canal begins in a funnel-shaped opening inclining to the lingual, as in Figure 1633, which quickly narrows



FIG. 1630.

FIG. 1631.

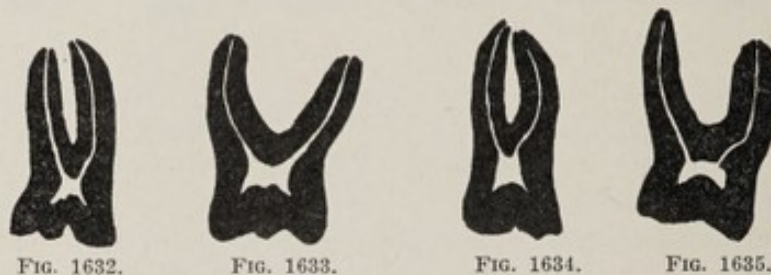
FIGS. 1630, 1631. Canals in upper first molars. Each figure represents three horizontal sections; the first through the pulp chamber, the second where the canals leave the pulp chamber, the third slightly farther apically.

to the dimensions of a moderately small canal and continues to taper to the apical foramen. It is usually very nearly straight. The approach to the canal with the broach is from the buccal, with a lingual inclination. The broach should be placed against the lingual wall and moved forward until it glides into the canal.

The opening of the mesio-buccal canal is under the mesio-buccal cusp, close against the mesio-buccal angle of the pulp chamber. It often happens that this canal opens in a groove in the angle of the chamber, Figures 1630 and 1631, making this the thinnest point in the dentinal walls surrounding it. In young teeth, the mouth of the canal is of a flattened funnel shape, which is quickly contracted into a very fine canal; but in the adult it often begins as a fine canal. Its course at first is to the buccal and mesial and then to the distal. It is usually distinctly flattened and often has a thin edge to the lingual. It is often a very difficult canal to clean with a broach. To find this canal, the point of the broach should be directed into the mesio-buccal angle of the pulp chamber, and while held against the wall within this angle, should be moved toward the root. It will rarely fail to glide into the canal.

The disto-buccal canal usually begins abruptly as a fine opening, situated at the disto-buccal angle of the floor of the pulp chamber, Figures 1630 and 1631, so that a broach pressed into that angle will easily glide into it. But in some instances, especially in the upper second molars, the opening is in the floor of the pulp chamber at a little distance from the immediate angle toward the center of the floor, and then, in positions which limit vision, it is often difficult to find. In teeth much flattened at the neck, the opening of this canal may begin very close to the mouth of the mesial canal, Figure 1632, or close against the distal wall, or, anywhere between this point and the disto-buccal angle. The first

direction of the canal will vary according to its position. If it is found in a fairly well-defined disto-buccal angle of the chamber, its direction will be a little inclined to the distal and the broach will penetrate it easily; if in the floor of the chamber, it will sometimes be straight, as in the former case; but, more generally, the first direction will be to the distal and buccal, with considerable curve afterward. If found close to the mesial canal, its course is usually first sharply to the distal, when it swerves rather abruptly toward the apex of the root. If found along a smooth or curved distal wall, the course will generally be to the distal and buccal with but little curve. This canal is usually very fine from its beginning, and almost or quite round.



FIGS. 1632, 1633, 1634, 1635. Canals in upper first molars. From right to left; the two buccal roots; mesio-buccal and lingual roots; the two buccal roots; disto-buccal and lingual roots.



FIGS. 1636, 1637. Canals in upper second molars. From right to left; the two buccal roots; disto-buccal and lingual roots.

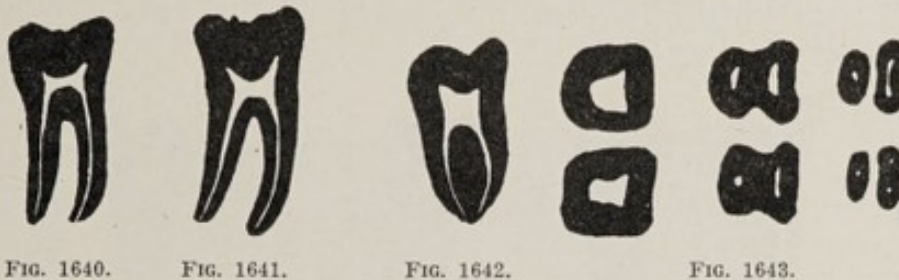
FIGS. 1638, 1639. Canals in upper third molars. Fig. 1638 shows mesio-buccal and lingual roots; Fig. 1639 the divided buccal canals in a single root.

While the canals are similar in all of the upper molars, there are differences in the form of the floor of the pulp chamber that may be briefly generalized. The pulp chamber of the upper second molar, Figures 1636 and 1637, is usually much more flattened mesio-distally than that of the first molar. This changes the relation of the openings of the canals somewhat, rendering the distal angle of the triangle formed by them more obtuse and brings the opening of the distal canal nearer the mesial line of the triangle, so that it seems to be found along the distal wall of the narrowed chamber. In others, it is found in the extreme buccal portion crowded close against the mouth of the mesial canal.

The position of the openings of the canals in the upper third

molar, Figures 1638 and 1639, is usually much the same as in the first and second, varying so as to resemble either. Occasionally there are more than the usual number; occasionally only one or two canals. When there is but one, it is commonly quite large. Four, five, or even seven or eight, are sometimes found.

LOCATION OF CANALS IN LOWER MOLARS. The pulp chambers of the lower molars, Figures 1640 to 1650, have the same general



FIGS. 1640, 1641, 1642, 1643. Canals in lower first molars. Figs. 1640 and 1641, mesio-distal sections; Fig. 1642, bucco-lingual section through mesial root; Fig. 1643, cross sections through pulp chamber, just below pulp chamber, and about midlength of the roots.

form as the surface of the crowns, but are generally rather more angular. The wall of the chamber toward the occlusal surface is convex toward the pulp; the horns extend from the extreme angles toward the apex of each cusp. The floor, through the central portion, is arched or convex from mesial to distal, and concave from buccal to lingual. The mesial wall of the cavity is flat and longer than the distal, which is rounded or concave. The mesio-buccal and mesio-lingual angles are sharp and projecting, while the distal angles are rounded, Figure 1643. The size of the chamber varies much. In youth, its diameter is often as much as two-fifths of the crown and seldom less than one-third. This diminishes as age advances, and in old age it is often very small; especially where there has been considerable abrasion of the teeth. the pulp chamber may be almost or quite obliterated.

The root canals of the lower molars proceed from the mesial and distal portions of the pulp chamber, Figures 1640, 1641, 1643, 1646, 1648 and 1650. The mesial canal, at its mouth, is usually about as broad from buccal to lingual as the whole breadth of the chamber, including its angular projections. Either at, or a little rootwise from, the floor of the pulp chamber, it is usually divided into two very small canals which diverge at first, and approach each other afterward, but usually remain distinct, each ending in its own apical foramen, Figure 1642. Occasionally, however, they are united in the apical third of the root, and end in a common apical foramen. Again, there may be a communication between them in the apical portion of the root, each canal remaining otherwise complete in itself, Figure 1647. A few have one broad flattened canal, Figure 1643. These canals are usually minute and very difficult to thoroughly clean with the broach,

though the mesio-buccal canal is usually easily found if the pulp chamber is well opened. By placing the point of the broach in the mesio-buccal angle of the chamber and pushing it gently on, it will generally glide into the canal. The first direction inclines to the mesial and buccal, after which it curves to the distal and lingual. Generally, these curves are easy, without short bends. The broach glides into the mesio-lingual canal by placing the point in the mesio-lingual angle of the pulp chamber and sliding it toward the root. The first inclination is to the mesial, but occasionally to the lingual, after which it curves to the distal and buccal.



FIG. 1644. FIG. 1645. FIG. 1646 FIG. 1647.

FIGS. 1644, 1645, 1646, 1647. Canals in lower second molars. From left to right; mesio-distal section; bucco-lingual section of tooth with one root and one canal, mesio-distal section; bucco-lingual section, through mesial root, with unusual formation.



FIG. 1648. FIG. 1649. FIG. 1650.

FIGS. 1648, 1649, 1650. Canals in lower third molars, mesio-distal sections.

The distal canal is approached by a funnel-shaped opening, of which the central part of the distal wall of the pulp chamber becomes a portion. Its direction is a little to the distal, and is generally very nearly straight to the apex. At first it is flattened with the long diameter from buccal to lingual, and progressively becomes rounded and tapers regularly to the apical foramen. It is larger than the canals of the mesial root and is easily cleaned with the broach. If the mouth of the patient is wide open and the handle of the broach brought against the upper central incisors with the point directed against the posterior wall of the pulp chamber, it will easily glide into the canal and pass to the apical foramen. This position is shown in the photograph, Figure 1651. This particular position for easily entering the distal canal is applicable to all the lower molars. Occasionally, the lower third molar has but one root canal, Figure 1649, which is generally very large. More rarely only a single canal will be found in the lower second molar; but generally, the canals of the second and third

lower molars are similar to those of the first. The pulp chambers are usually smaller and more often irregular in outline.

VARIATIONS OF THE FORMS OF PULP CHAMBERS. Many variations of form occur in the pulp chambers and root canals. The roots of the teeth may be abnormally crooked. In many instances, the pulp chamber will have in it secondary calcifications — nodules, which may be adherent to the walls or block the openings of the canals and prevent a broach from gliding into them. These also occur, occasionally, within the canals, partially blocking the way of the broach. Sometimes the pulp chamber will be filled with nodular



FIG. 1651. Photograph showing the position for passing a broach into the canal of the distal root of any one of the lower molars. The removal of the pulp, the cleaning and filling of this particular canal is done best from about this position.

deposits so completely that there seems to be no room for the tissues of the pulp. These deposits must be removed before the root canals can be reached and entered, after which the canals will generally be found open. Such deposits occur within the pulp chambers of any of the teeth, but they cause annoyance most frequently in the molars.

Occasionally lateral openings occur from the root canals to the surface of the root. More of these have been seen from the canals of the lower molars than any other teeth. Generally they follow the course of the dentinal tubules and open on the side of the root. They may diverge to one side and curve toward the apex of the root. These can not often be detected, except in dissections of the root, and occur so rarely they may be ignored in practice.

Sometimes the horns of the pulp approach abnormally near the points of the cusps of some of the teeth, as in the upper first bicuspid, and in the mesio-buccal cusp of the upper first molar.

Then the pulp is more liable to exposure in excavating carious cavities.

OPENING PULP CHAMBERS IN SOUND TEETH. Occasionally it is necessary to open the pulp chambers of teeth that are sound, or that have restorations previously inserted, the removal of which is not indicated. The pulp may be dead or in such a condition of disease that it should be removed. In these cases, it becomes necessary to cut from the surface of the tooth or through the restoration.

IN INCISORS AND CUSPIDS. In case of the incisors or cuspids, the best place to enter the pulp chamber is through the central portion of the lingual surface. For this purpose, a bibeveled drill, one millimeter in diameter, should be first used. Its cutting edges should be very sharp. With this the enamel should be penetrated



FIG. 1652.



FIG. 1653.



FIG. 1654.

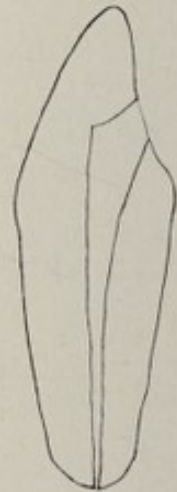


FIG. 1655.

FIGS. 1652, 1653, 1654 and 1655. Outline drawings illustrating the opening of the pulp chamber and canals in the incisor teeth when this is done through the lingual surface.

and the drill forced a little distance into the dentin. This opening should be considerably enlarged by a larger drill or a round bur. Then the small drill should be forced ahead and by several changes of these instruments the pulp chamber may be reached. The point of the small drill should never penetrate very deeply in the small hole. Neglect of this precaution is liable to cause unnecessary pain, or to break the point of the drill by some quick movement of the patient. If the pulp is vital and sensitive, it should now be anesthetized. Afterward the complete opening of the chamber may be proceeded with. If the pulp is dead, the further opening of the chamber may be done at once.

In cutting into the pulp chamber through the lingual surface of incisors, the drill has entered from the lingual at a considerable inclination, as shown in Figure 1652, and it is necessary to make the opening as nearly parallel with the length of the pulp canal as

practicable. To do this, a fissure bur should be used. Its end should be passed into the pulp chamber and the handpiece brought slowly parallel with the long axis of the tooth, cutting from the incisal wall of the opening first made, as shown in Figure 1653; then with the same instrument passed farther in, the lingual wall of the pulp chamber should be cut away, going deeper into the root canal carefully, so as not to mar the labial side, until the form shown in Figure 1654 is obtained. This cutting should be sufficient to admit a broach to the full length of the canal, with a very little bending. Unless there is reason for delay, as on account of soreness of the tooth, the incisal end of the pulp chamber, which, as in Figure 1654, can not be reached for cleaning or filling, should be opened by cutting away the tissue, as shown in Figure 1655. This should always be done before a filling is made. Otherwise a little tissue or debris will be left, which will decompose later and discolor the tooth. It is also necessary that this be opened so that it may be solidly filled. When this has been completed, the cleaning and treatment of the canal can be proceeded with.

Generally, when incisors have proximal restorations that are good, the opening into the pulp should be made from the lingual, as above described, without disturbing the restorations. If, however, there is reason for removing a proximal restoration, the pulp chamber should be opened through the cavity.

The different teeth of each class show much variation in form and position, which makes considerable difference in the cutting necessary to so straighten the line of approach that the broach and the root canal plugger will go easily to the apex of the root canal, or canals, without so much bending as to interfere with their effective use. Some are of such form, and the line of approach is such, that this is easily obtained while others are very much more difficult. But in almost every case fairly free working of these instruments can be obtained by judicious cutting, which will not be excessive in lines that will materially injure the strength of the teeth. As the future usefulness of the teeth will depend upon the effectiveness of the treatment of the root canals, one should not be satisfied to undertake this without the best access for these instruments that can be reasonably obtained.

IN BICUSPIDS AND MOLARS. In bicuspid and molars, the opening should be made through the occlusal surface. In bicuspid the mesial pit should be chosen. In molars it is generally much easier to penetrate the enamel through the pit in the central fossa. In this case, as soon as the dentin has been entered it is best to introduce a small inverted cone bur and cut a slot to the mesial inclining to the buccal, and chip the enamel from its margins. The length of this toward the mesial will depend on the position of the tooth and the inclination of the hand-piece in drilling through the dentin. In this, the object is to gain a position from which the drill can be directed into the pulp chamber centrally

or toward its mesial portion. The dentin is thick, and, in passing through it from the central pit, this inclination will often carry the hole considerably to the distal. Therefore, in beginning again with the drill, it should be set sufficiently to the mesial so that it will strike the pulp chamber centrally, or to the mesial of its center, as stated. In drilling through the dentin, a small drill, one millimeter in diameter, should first be made to penetrate a little, and then the hole enlarged, then drilled deeper and enlarged, continuing this exchange of instruments until the dentin has been cut through. It should be recognized that there is always danger that a small drill is liable to clog with its chips and to heat, or that it may be broken and the end remain fast in the hole. Or some sudden movement of the patient may break it. For these reasons, a small drill should not be sunk very deeply into the dentin at any time without having enlarged the opening through which it works. The opening should not be made with a large drill in the first instance, because this requires too much force. Presuming the pulp to be dead, the opening may at once be so enlarged as to remove the entire roof of the pulp chamber, and the treatment of the canals proceeded with.

In a considerable number of cases it is necessary to open the pulp chambers of bicuspid and molar teeth, in which restorations have been placed. If the restorations are good, one should proceed as if the tooth were sound, cutting through the restoration, or through the dentin, as the case demands. If there is reason for removing the restoration, this should be done at once, and the pulp chamber should be opened through the cavity.

TREATMENT OF TEETH HAVING DEAD PULPS.

CONDITIONS PRESENTING. Teeth containing dead pulps may present in any of the following conditions: (1) The pulp may be dead and may not be infected, either by exposure to the fluids of the mouth, or via the circulation; (2) the pulp may be dead and infected, without having been exposed to the fluids of the mouth; (3) the pulp may be dead and infected, being exposed to the fluids of the mouth. If the pulp is dead and not infected, the soft tissues about the apex of the root will not be inflamed. If the pulp is infected, there may be no disease of the periapical tissues, or there may be an apical pericementitis, a granuloma, a cyst or an acute or chronic periapical abscess. These will be discussed later, and the time when the dead pulp should be removed will be considered in each condition. In every case presenting with a dead pulp, a radiograph should be made to determine if any portion of the periapical bone has been destroyed. The prognosis, so far as the future of the tooth is concerned, in the case of a dead pulp without periapical infection is practically the same as though a vital pulp had been removed.

Cases in which the pulp is dead and not infected are neces-

sarily cases in which the pulp has not been exposed to the fluids of the mouth. This condition occurs most frequently from hyperemia induced by thermal shock, less often by accidental blows, etc. Those cases in which the pulp is dead and infected, without having been exposed to the fluids of the mouth, occur from the same causes, the infection having been brought to the pulp through the circulation. There is an occasional case, closely related to this group, in which the pulp dies without having been exposed to the fluids of the mouth by a cavity of decay, but in which an inflammation of the peridental membrane beginning at the gingival line has destroyed the attachment of this tissue entirely to and around the apex of the root, thus causing the death of the pulp. In the multirrooted teeth, the pulp may be cut off and infected at the apex of one root and yet more or less of the pulp tissue will be kept alive for a considerable time by the circulation through the apices of the other roots. Such a pulp may give a definite response to a vitality test. This happens most frequently in cases of chronic pericementitis, involving the lingual root of the upper first molar.

TECHNIC OF TREATMENT. ASEPSIS. In considering the technic of treating such cases, the first proposition is that the pulp chamber and root canals are infected districts, which are to be made aseptic. There seems to be a sentiment among older practitioners that there is no need of aseptic precautions in approaching these, since they are already infected. This is distinctly wrong. In the great majority of cases, the infections are with the mildly pathogenic micro-organisms. Root canals that open into a cavity of decay may contain saprophitic micro-organisms only, which are incapable of spreading into the living soft tissues by growth and producing disease in that way. Their products of decomposition in the root canals may, however, be very irritating and cause an inflammation when passed through the apical foramen. In any of these cases there is always the danger of introducing more virulent pathogenic micro-organisms during the treatment, unless diligent aseptic precautions are employed in the approach. There should be no difference in this respect whatever in the two classes of cases.

INSTRUMENTATION. The instruments used in cleaning the canals are the barbed broach and the smooth broach, and sterile bibulous paper points, the same instruments as used in aseptic cases. The rubber dam must protect the parts, and the field of operation must be aseptized. If the canals contain fluid, this should be carefully absorbed away as the first procedure, with the paper points. To avoid the danger of pushing the fluid beyond the apical foramen and causing unnecessary inflammation of the peridental membrane, the surface of the fluid contents should be touched with the paper point and lightly absorbed, then drawn away without pressure. If the canal is reasonably dry, a barbed broach that enters the canal loosely should be introduced carefully

some little distance and withdrawn. The barbs are so cut that they hold debris or shreds of decomposing tissue on the pull and bring away any such material with which they come in contact. In all cases, regardless of whether the tooth has been comfortable or has caused pain, it is inadvisable to endeavor to completely remove the contents of the canal at the first appointment, because of the danger of forcing some of the presumably infected tissue through the apical foramen. When the bulbous portion of the pulp, and possibly a little from the canals has been removed, a medicament should be sealed in for the purpose of destroying whatever of infection may be present. Of the available drugs, creosote is recommended, because its bactericidal value is high and it does not irritate soft tissues. See Figure 1605.

When the patient returns, the broaching should be continued, washing the broach repeatedly in the sterilizing fluid and continuing until the canal is cleaned to its apex. During this process the broach should be inclined this way and that in its withdrawal so as to effectively scrape all parts of the walls of the canal with barbs, loosening and removing all adhering particles. Finally, the canal should be flooded with a mild antiseptic, such as eugenol, and the broaching repeated. The medicament should then be absorbed away. This should be repeated until the canal is judged to be well cleaned. Then it should be dried with frequent introduction of paper points or sterile cotton wound upon the smooth broach and so rotated as to entangle and remove any particles which may possibly have been left.

Special care should be taken that the cotton on the smooth broach shall not be in such quantity to form a piston that will push material from the canal through the apex of the root into the tissues beyond; also that the barbed broach be not used in such a way as to gather shreds of material before it and push some of the contents into the tissue beyond the apex of the root. This pushing of material through the apex of the canal, which is liable to produce inflammation, is the one great danger in cleaning infected root canals. With the proper sealing of the cavity, the pulp chamber and root canals are a sealed box, the disinfection of which is easily commanded. There is no reason whatever for the use of irritating germicides in its disinfection.

SEAL TREATMENT. When the cleaning has been completed, a paper point should first be moistened with the desired medicament and then placed loosely in the root canal, or in each root canal, when there are more than one. In sealing the treatment, every precaution should be taken to prevent the possibility of forcing some of the infected contents of the canals through the apical foramen. It is desirable that a piece of matrix metal, or some other material conveniently at hand, be laid in the pulp chamber in such a way that it will protect the contents of the canals from pressure by the gutta-percha.

The treatment is sealed in the tooth for the purpose of establishing and maintaining a sterile field. If any of the infected contents of the canal shall have been forced through the apical foramen by either the broaching or pressure in connection with the sealing of the cavity, a pericementitis may develop within the next twenty-four hours. If so, the treatment should be changed under aseptic conditions with the rubber dam in place and the tooth will usually be comfortable afterwards. To leave the root canal open, as was formerly the practice, oftentimes exposes the pulp and periapical tissues to infection of a more severe type of organisms than those with which it was previously involved.

TREATMENT OF PULP CHAMBERS WHICH HAVE BEEN NARROWED BY CALCIFIC DEPOSITS.

When the pulp chamber is filled with secondary deposits, the effort should be directed to the removal of these, preserving the outlines of the pulp chamber. When the pulp chamber is much narrowed by secondary dentin deposited upon its walls, the openings into the canals should be found before any cutting is done, and then the cutting carefully directed to straightening them. In most instances this is done best with the barbed broach. All small tortuous canals should be enlarged and straightened with the barbed broach. To do this, the broach should be passed into the canal as far as possible and withdrawn. The barbs will impinge upon the walls and cut away the dentin from the prominent parts of the crooks and straighten them. This should be repeated again and again, pressing the broach in a direction during its withdrawal that will tend most to straighten the canal. By repetitions of the movement, a canal which can be entered by the smallest broach can soon be enlarged sufficiently for filling. When canals are so small that the smallest barbed broach will not enter, a fine smooth broach, which has been roughened with a file, may be used for the first trimming.*

Attention has been called to the fact that the root canals generally become smaller with advancing years, due to the continued or intermittant activities of the odontoblasts in building additional dentin. There are wide variations; in the mouth of one person, the canals may be as much reduced at thirty years of age as in another at sixty. In many cases, the technic of enlarging the canals is similar to that just described for the straightening of canals which are curved. If the finest smooth broach may be passed into a canal, there should be little difficulty in enlarging it, although great patience is often required.

* To roughen a broach with a file, one should use a flat file cut only one way—not cross cut. The broach should be laid on a piece of moderately hard wood and the file carried diagonally across it, the broach being permitted to roll under the file, while a single motion is made with heavy pressure. The file cuts will tend to cut barbs on the broach in a spiral form around it. If this is properly done, such a broach will cut the dentin quite readily.

The technic of enlarging canals is illustrated in Figures 1656A, B, C, D and E. The roots of two upper central incisors, in the mouth of a man fifty years of age, are shown in Figure 1656A. These canals become very small toward the apices of the roots. A very fine smooth broach passed as far as the size of the canal permitted without undue pressure, is shown in the root to the right in Figure 1656B. This broach was then roughened with a file and was gradually carried farther toward the apex in each canal, by slight pressure, while slowly turning the broach, followed by its withdrawal into the larger portion of the canal. This was repeated again and again, removing a little of the dentin at each effort. Diagnostic wires were then placed in both canals, as shown in Figure 1656C. These did not reach the apex of either root and the broaching was

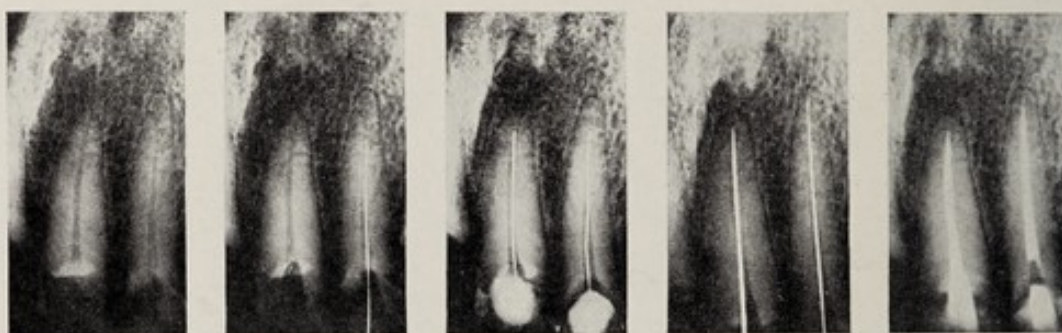


FIG. 1656A.

FIG. 1656B.

FIG. 1656C.

FIG. 1656D.

FIG. 1656E.

FIGS. 1656A to E. The technic of enlarging canals.

continued until larger broaches could be passed quite to the apex of each. In Figure 1656D, the larger broach is fully to the apex in the tooth to the right, but is a little short in the tooth to the left. Finally, after taking proper measurements, the root fillings were made as shown in Figure 1656E.

Generally, partial occlusions of canals are confined to or near their pulpal ends, and when these have been enlarged, the broach will pass to the apex. In elderly people certain canals are often too small for successful cleaning and filling. In cases in which there has been much abrasion, the pulp chambers and the pulpal ends of the root canals are apt to be much narrowed by secondary dentin. This applies to all of the teeth in the mouth — i. e., to any that have from any cause, not been worn away, the same as those which are worn.

REMOVAL OF CALCIFICATIONS FROM ROOT CANALS. If there are many fusiform calcifications in the root canals they will often interfere seriously with passing a broach to, or nearly to the apical foramen. One who has had experience will recognize by

the sense of touch that the difficulty is due to this kind of calcification. Then the object should be to force the broach as far as possible alongside of such calcifications, and in withdrawing it, obtain room to thrust the broach still further. Finally, if the approach to the canal has been well opened, the broach will catch the mass in such a way as to withdraw it as a whole, cleaning the canal very effectively. Occasionally, however, the whole mass will have to be broken, by continuous probing, cutting out a little at a time until the canal is cleaned of its contents. This is tedious. Often there is a shoulder left near the opening of the canal. If this is cut away, the entire contents of the canal may come away easily. This is an operation requiring experience and a great deal of patience for the best success.

REMOVAL OF PREVIOUS ROOT CANAL FILLINGS.

A number of cases present with inflammation of the periapical tissues, in which the root canal has been previously treated and a root filling made. It may be that all of the pulp tissue was not removed, and the portion remaining became infected; or the root may not have been filled to the apex and serum collected in the open space and became infected; or the root filling may have been pushed through beyond the apex, causing an inflammation.

A radiograph will usually be of great value in determining the difficulties to be encountered and the proper course of procedure. If it is decided to attempt to remove the previous root canal filling, proper access to the canal, or canals, must be had, the same as though the pulp were to be removed. If the root filling has been reasonably well made it will often be impossible to remove it. Supposing the root filling to have been made of gutta-percha, a first effort should be made by heating a root canal plugger and passing it into the gutta-percha. Some of it can usually be removed in this way, and a number of efforts may remove a fair portion. The gutta-percha may be softened beyond the point reached by the end of the plugger, in which case a barbed broach or a twisted broach may bring away the remainder. If these fail, xylol may be sealed in the canal for twenty-four hours to soften the gutta-percha. It may then be possible to remove it with a broach. The removal of a root filling will often severely tax the patience of the operator, and the most painstaking and persistent efforts may not be successful. One rule should be followed, viz., no instrument in the engine should be used in the effort to reach the apex of a root, on account of the danger of cutting through the side of the root, an accident which practically always results in the loss of the tooth.

Filling Root Canals

TABULATION OF GOOD AND POOR ROOT FILLINGS IN RELATION TO THE OCCURRENCE OF PERIAPICAL ABSCESS. In a paper* read before the American Medical Association, a critical examination of radiograms of 1,510 root canal fillings in relation to the occurrence of periapical abscess was reported. These root fillings were grouped according to the sizes of the canals, whether large or small. They were also tabulated as good or poor root fillings, judged from the radiograms. If the root filling apparently filled the apical portion of the canal, or if it did not quite reach the apex and the canal from that point to the apex could not be made out with a magnifying glass, it was classified as a "good" root filling. If any portion of open canal was visible apically of the filling, or if the root filling appeared to be smaller in diameter than the canal, there being a space alongside of it, or if any of the root filling material protruded beyond the apex, it was classified as a "poor" root filling. The following is the tabulation:

Good root fillings, large canals, 343	Number abscessed, 31
Good root fillings, small canals, 184	Number abscessed, 19
<hr/> Total, good root fillings, 527	<hr/> 50
Poor root fillings, large canals, 570	Number abscessed, 356
Poor root fillings, small canals, 413	Number abscessed, 271
<hr/> Total, poor root fillings, 983	<hr/> 627
Total .....1,510	<hr/> 677

Percentage of abscesses for all root fillings, 45; for good root fillings, 9; for poor root fillings, 63.

It is quite certain that a percentage of these teeth were already abscessed when the root fillings were made, and some may have resulted from other causes than poor technic; nevertheless, the wide difference between 9 per cent for good root fillings and 63 per cent for poor root fillings emphasizes the importance of greater care in the filling of root canals.

PREPARATION. When it is decided that the conditions are right for filling the root canal, or canals, of a tooth, the rubber dam must be placed and the included region aseptized. Then if a treatment has been in the canal, the gutta-percha filling and the dressing should be removed and a critical examination made as to its condition. One principal point is that the canal should be dry.

INSTRUMENTS. The only additional instruments to those already mentioned for pulp treatment are several sizes of root canal pluggers. These may be straight, with sufficient flexibility to permit the ends to be bent in any desired direction, or they may be contra-angled instruments, as illustrated in Figure 1657, only the

* Journal American Medical Association, October 19, 1918, Vol. 71, p. 1279.

working ends of which are flexible. If contra-angled instruments are used, it is of much importance that the working point is very closely in line with the center of the handle, to give proper balance.

SIZE OF FORAMEN AND LENGTH OF CANAL. The size of the apical foramen should be ascertained by trying several sizes of root canal pluggers in the canal. Those that are smaller than the foramen will pass through and will be felt by the patient. By beginning with a large point, and trying smaller points in graded sizes, one will be found that will just pass through the apical foramen. The length of the root may be ascertained by sticking the point of a smooth broach through a little piece of rubber dam and holding the piece of rubber even with the incisal end, occlusal surface, or any convenient landmark on the tooth, while the broach is passed to the apical foramen and is felt by the patient. When the broach is withdrawn, the distance from the rubber to the point will be the length of the tooth.

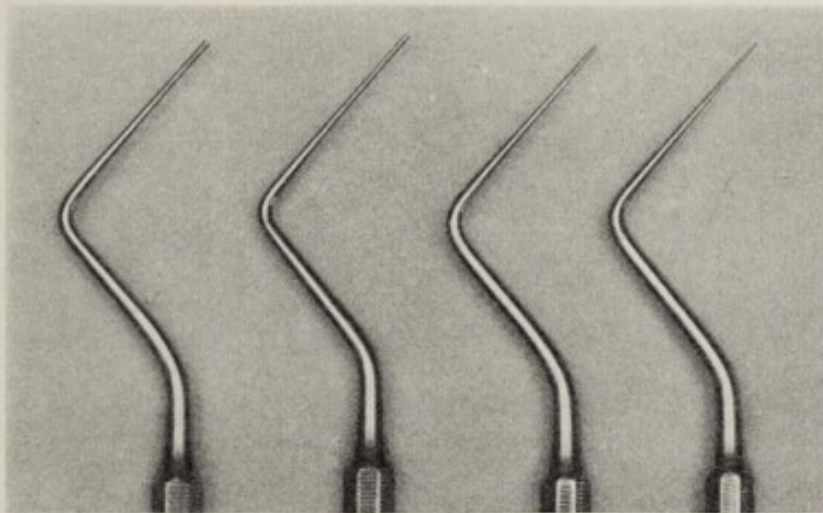


FIG. 1657. Root-canal pluggers.

The size of the foramen and the length of the root may be very accurately determined with the X-ray. For this purpose, several sizes of brass wire should be kept on hand, and in each case a size which may be passed nearly to the apex should be used. A piece of this wire should be passed into the canal, the other end should be doubled back so as to project a very slight distance into the canal—only far enough that the end will not be obscured on the film by the gutta-percha with which the cavity is sealed. A radiograph should then be made. This may not show the real length of the root, but its actual length may be determined by comparing the actual length of the wire with its shadow on the film. Figures 1658, 1659 and 1660 are reproductions of three radiographs of the same upper cuspid with a wire in the canal, showing variations in the projection of the root shadow on the film. For

example, if the wire is 14 mm. long, and in the radiogram it measures 16 mm. while the root in the radiogram measures 20 mm., the actual length of the root would be 17.5 mm., as its length would be exaggerated in the radiogram in the same proportion as the wire.

TECHNIC FOR LARGE CANALS. The canal should be moistened with eucalyptol or oil of cajuput, liberally applied upon a paper point and the excess should be removed. A gutta-percha cone should be selected and about two or three millimeters should be cut off to use. This piece should be of a size which, from the information gained of the size of the apical end of the canal, will be sufficient to fully fill the opening and not be forced through it. A root canal plugger of proper size, tested by passing it into the canal as far as it will need to go, should be made to penetrate a little piece of rubber dam. Then the end should be warmed in the flame, and while holding the piece of gutta-percha cone in the thumb and finger of the left hand, its point should be brought quickly in

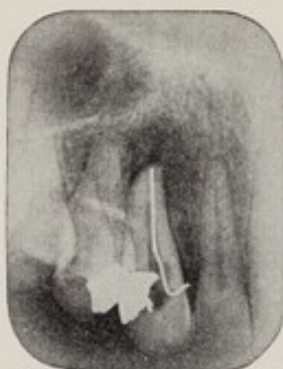


FIG. 1658.



FIG. 1659.

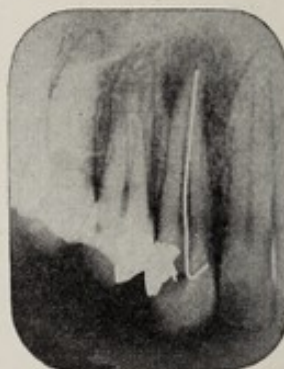


FIG. 1660.

FIGS. 1658, 1659, 1660. Three radiographs of the same upper cuspid with a wire in the canal, to show the difference in the shadow-length of the root, as a result of the direction of the rays and the position of the film. With the length of the wire known, the length of the root can be definitely determined from the shadow-length on the film, no matter what the distortion.

contact with the large end of the cone and held a moment or until the gutta-percha has stuck to the end of the instrument. After it has cooled a little, it may be more securely fastened to the plugger by heating the beaver-tailed burnisher and pressing the gutta-percha from the sides of the cone against the sides of the root canal plugger, near its end. The gutta-percha is thus attached not only on the flat end of the plugger, but also entirely around the outer surface, near the end. When the gutta-percha has had time to become cold and hard, the piece of rubber dam should be placed at the proper position on the plugger that the distance to the point of the gutta-percha will correspond to the length of the tooth, as previously determined. The end of the plugger, carrying the gutta-percha cone should be immersed in the sterilizing fluid and should be conveyed to the root canal and carried carefully and firmly to its apical end, as will be determined by the position of the piece of rubber dam. On withdrawing the root plugger, the

gutta-percha cone will remain, closing the apical end of the root. This procedure should be followed with other bits of gutta-percha cones, cut from larger parts of the cones as the canal is filled to its larger portion, using larger root canal pluggers. After the first two or three pieces, the subsequent ones may be slightly softened by passing them quickly over a flame and directly into the canal. This should be continued until the canal is full.

RATIONALE OF THIS PROCEDURE. By placing eucalyptol in the canal, any moisture that may be in the canal is effectively removed. The oils have a greater affinity, or attraction, for the dentin than has the moisture and therefore displace it. In practice this is a much better method than drying with hot air or hot instruments. The drying is done much more perfectly and more easily. The eucalyptol dissolves gutta-percha slightly, and the little oil remaining serves to stick the gutta-percha firmly to the walls of the canal. By putting in the gutta-percha in small pieces, an opportunity is given to pack every portion of the canal and all of its irregularities full.

In filling root canals that are very large at the apical end, as in young persons, care must be exercised that the first cone selected is not so small that it could be forced through into the apical space.

TECHNIC FOR SMALL CANALS. In very small canals, in which there is much doubt of being able to reach the apical end with a gutta-percha cone, chloro-percha (gutta-percha dissolved in chloroform) should be pumped into them with a broach, filling them as completely as possible. A root canal plugger of suitable size may then be thrust into the chloro-percha to force some of it from the pulpal end, leaving a film of chloro-percha attached to the walls of the canal. A suitable gutta-percha cone, previously prepared, may then be thrust as far into the canal as possible. Such canals may not always be perfectly filled by this plan, nor by any other, but in each case the best effort should be made.

CANALS GROUPED INTO TWO CLASSES. While it is impracticable to definitely group the canals of the various teeth into two classes, it may be said that chloro-percha will generally be needed in the upper laterals, first bicuspid and buccal canals of molars, also in the lower incisors and mesial canals of molars. Chloro-percha should generally not be necessary in the upper centrals, cuspids, second bicuspid and lingual canals of molars; nor in the lower cuspids, bicuspid and distal canals of molars. There will be many exceptions owing to variations in the sizes of canals, formations of secondary dentin, the age of the patient, etc.

The pulp chamber should not be filled with gutta-percha. This material is much too soft to serve as a seat for a metallic restoration. In any case in which it is not desirable to fill the pulp chamber with the material with which the cavity is to be filled, oxyphosphate of zinc should be used.

TO PREVENT EVAPORATION OF CHLORO-PERCHA. The evaporation of chloroform from chloro-percha may be prevented, in large measure, by keeping the bottle containing the solution upside down. By standing the bottle on its cork, a little of the chloro-percha will pass in between the cork and the opening of the bottle, and as the chloroform evaporates from this portion, the remaining gutta-percha will seal the opening so that no more chloroform may evaporate. The contents of the bottle will therefore remain in a plastic state, ready for use at any time. A cork stopper is preferable to a ground glass stopper for this purpose.

HORNS OF PULP CHAMBERS. Attention to the horns of pulp chambers is most urgently demanded in the incisors, cuspids and bicuspid. In incisors particularly, exposure of the pulp, whether made primarily by caries or by cutting into them, are usually at some distance from the incisal end of the pulp, leaving an end protruding into the incisal end of the crown of the tooth. This has been especially illustrated in Figures 1652 to 1655. In the cuspids and bicuspid, the horns of the pulp are often long and slender and penetrate far toward the ends of the cusps. Unless these are thought of and especially looked for and cut out, so that they may be perfectly filled, discoloration of the tooth in some degree is sure to occur. This may occur in the molars as well, especially in young persons whose teeth have long cusps. Nothing of this kind should escape notice and correction.

Radiographic Studies of Root Fillings

A number of photographic reproductions of radiographs are presented to illustrate the results that may be obtained by following the technic recommended. These root canals were treated and filled by students in Northwestern University Dental School. They are a part of a collection of several thousand which are being used in a special study of changes which may occur in the periapical tissues, when the various steps in the treatment of the pulps and the filling of the root canals are carried out to the most minute details. Accurate records are being kept as to the condition of the pulp and periapical tissues at the time treatment was undertaken, also of medicaments used, and other essential data, including the age of the patient. Notices are sent to these patients every six months, requesting them to return for a radiographic check-up, which is made without charge.

In the accompanying illustrations, only two radiographs of each tooth are reproduced; the first was taken when the diagnostic wire was in the canal; the second is from the last film of the particular tooth, which may have been taken at any time from six months to four years after the root filling was made.

This study includes every type of case that presents — vital pulps which were not inflamed, vital pulps exposed by caries, some of which had been exposed to the fluids of the mouth, dead pulps without apparent involvement of the periapical tissues, and cases

in which the radiograph showed definite rarefaction of bone about the apex. One of the latter is shown in Figures 1750 to 1753. These cases are also being examined with subsequent radiographs to learn what changes take place in the bone during a period of years, following the rebuilding about the apex of the root, which often occurs rather promptly after the dead pulp is removed.

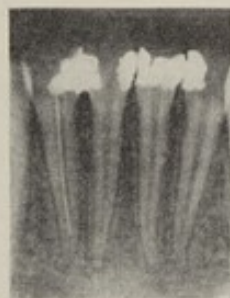


FIG. 1661A.



FIG. 1661B.



FIG. 1662A.



FIG. 1662B.



FIG. 1663A.



FIG. 1663B.



FIG. 1664A.



FIG. 1664B.

Figures 1661 A and B show the four lower incisors of a boy fifteen years of age. The left lateral and central incisors required treatment. The canals are large and should be satisfactorily filled, notwithstanding the slight bend in the lateral incisor root near the apex. The diagnostic wire is shown in this tooth. In placing the root filling, the canal was first moistened with eucalyptol, followed by chloro-percha, and a little of the chloro-percha was forced through the apex.

Figures 1662 A and B show an upper lateral incisor in a patient sixteen years of age. The diagnostic wire reached almost to the apex. Chloro-percha was not used. The root appears to be very perfectly filled.

Figures 1663 A and B show the diagnostic wire and root filling in an upper lateral incisor for a patient twenty-six years old. The root filling extends slightly farther than the diagnostic wire and the canal is not visible beyond.

In Figures 1664 A and B, the diagnostic wire and the root canal filling extend fully to the apex. Although this patient was forty-five years of age, it was not necessary to enlarge the canal.



FIG. 1665A.



FIG. 1665B.



FIG. 1666A.



FIG. 1666B.



FIG. 1667A.



FIG. 1667B.



FIG. 1668A.

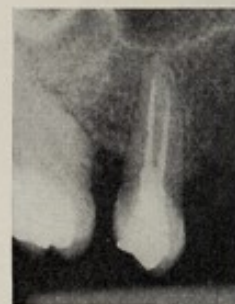


FIG. 1668B.

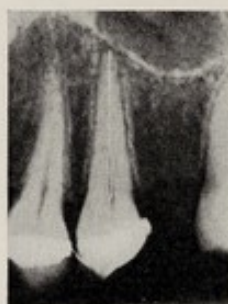


FIG. 1669A.

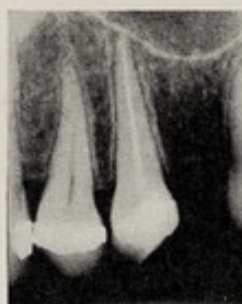


FIG. 1669B.



FIG. 1670A.



FIG. 1670B.

Figures 1665 A and B show an upper first bicuspid. Both diagnostic wires were accurately placed, as were the root fillings. Chloro-percha was used. Patient was fifteen years old.

Figures 1666 A and B illustrate the procedure in an upper second bicuspid for a patient sixteen years old. The canal was not enlarged. The gutta-percha point does not extend quite to the apex.

Figures 1667 A and B show an upper first bicuspid with both canals filled to their apices.

Figures 1668 A and B show an upper first bicuspid; patient twenty-one years old. This tooth was slightly rotated, so that both canals are shown. The fillings do not reach to the end of either root. Examination of the film with a magnifying glass failed to show any indication of the canals beyond the gutta-percha points.

Figures 1669 A and B show an upper second bicuspid in the mouth of a patient twenty-four years old. The diagnostic wire extended exactly to the apex of the root, as does the root filling.

In Figures 1670 A and B, the treatment of an upper second bicuspid with two root canals is illustrated. It will be noted that one of the diagnostic wires penetrated the floor of the maxillary sinus. However, the root filling appears to be perfect.



FIG. 1671A.



FIG. 1671B.



FIG. 1672A.



FIG. 1672B.

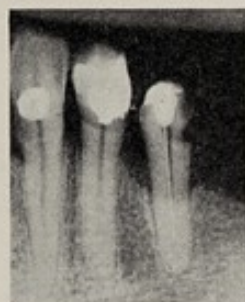


FIG. 1673A.



FIG. 1673B.



FIG. 1674A.



FIG. 1674B.



FIG. 1675A.

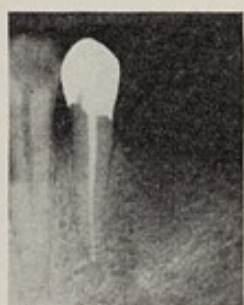


FIG. 1675B.



FIG. 1676A.



FIG. 1676B.

Figures 1671 A and B show a lower second bicuspid. The diagnostic wire did not follow the curve of the canal. However, the measurement seems to have been accurate, as the gutta-percha appears to fill the canal perfectly.

Figures 1672 A and B show a lower first bicuspid in the mouth of a patient twenty-two years of age. The root filling appears to be a fraction of a millimeter short of the apex.

Figures 1673 A and B are from a lower second bicuspid in which the diagnostic wire and the root filling extend exactly to the apex of the root. This patient was forty years of age.

Figures 1674 A and B show an excellent root filling in a lower first bicuspid.

Figures 1675 A and B are from radiographs of a lower first bicuspid in the mouth of a man fifty-two years of age. This is another case in which considerable broaching was necessary to enlarge the apical portion of the canal. The root filling is excellent.

Figures 1676 A and B are for a patient seventy-three years of age. Broaches were used to enlarge the canal previous to the placing of the diagnostic wire. There appears to be a slight rarefaction about the apex of the first bicuspid in Figure 1676B.



FIG. 1677A.



FIG. 1677B.



FIG. 1678A.



FIG. 1678B.



FIG. 1679A.



FIG. 1679B.



FIG. 1680A.



FIG. 1680B.

Figures 1677 A and B illustrate the case of a lower first molar in the mouth of a boy fifteen years old. One of the diagnostic wires in the mesial root was considerably short of the apex. There had apparently been some disturbance of the bone at the apices of both roots as shown in Figure 1677A. The radiograph from which Figure 1677B was made was taken six months later and the bone is assuming more nearly normal structure.

Figures 1678 A and B show another lower first molar in which an excellent root filling was made, although the diagnostic wires were far short of the apex in the mesial root.

Figures 1679 A and B show an upper first molar. The filling in the mesio-buccal root is directly in line with that in the lingual root. Another radiograph, taken at a slightly different angle, would show both canals.

Figures 1680 A and B illustrate the treatment of a lower first molar for a patient forty-five years of age. Considerable enlargement of the apical portions of the mesial canals was necessary.

Chronic Periapical Infections

BIBLIOGRAPHY ON PERIAPICAL INFECTIONS PAGE 411

ILLUSTRATIONS: FIGURES 1701-1758.

PERIAPICAL infections occur as direct sequellae of the death of the pulp, or secondarily, from conditions prevailing within the root canal or about the apex of the root following the removal of either vital or dead pulps and the placing of root canal fillings. The conditions in the periapical region vary greatly in accordance with the type of infection and other circumstances in the particular case. At the time of the examination of a particular case there may be an acute or chronic pericementitis, a granuloma, an acute or chronic abscess, rarely a case of chronic osteitis, or a root cyst. There is no definite order in which these several conditions occur. An acute abscess may occur first, followed by a chronic abscess, or a chronic abscess may be present for years and an acute condition may at any time supervene because of infection by more virulent organisms. An intermediate stage may be a granuloma, or the proliferation of the epithelial cells of the region may result in the formation of a cyst, which may in turn become infected and thus be changed to an abscess, either chronic or acute. The inflammation may be limited to either an acute or chronic pericementitis, and there may be complete recovery following the removal of the pulp and the treatment of the canal.

A *granuloma* may be defined as a collection of infiltrating cells in a network of connective tissue. The cell types include lymphocytes, plasma cells, young fibroblasts and occasionally epithelial cells.

An *abscess* is a collection of pus in a cavity, formed within the tissues of the body as a result of suppuration. A periapical or alveolar abscess is so named because it occurs within the bone of the periapical region, or within the bone which forms the alveolar process.

A *cyst* is an encapsulated cavity containing a fluid, which is secreted by epithelial cells that form the lining of the wall of the cyst cavity. The fluid of a cyst may contain cholesterol crystals and is usually sterile, so long as the wall is intact. A cyst occurring within the tissues about the apex of the root of a tooth is called a periapical cyst, a radicular cyst or a root cyst.

Chronic osteitis is a rather rare condition in which the bone is gradually softened and destroyed, without the formation of a limiting membrane.

FREQUENCY.

In a report* of an examination of 6,000 radiographs of the mouths of 600 adults, without previous inquiry as to the condition of their general health or of their teeth, the effort being to learn average conditions, the following tabulation appears:

Age	Number of persons	Number having bone destroyed at root apices	Percentage having bone destroyed	Average number of abscesses per person for entire number in group
20 to 24.....	146	77	52	1.4
25 to 29.....	119	60	51	1.3
30 to 39.....	146	92	63	1.4
40 to 49.....	111	65	59	1.5
50 and over.....	78	39	50	1.3
	600	333	55	1.4

In this report, the term chronic abscess was applied to all chronic conditions which caused a rarefaction of bone about the apex of the root. The examination was, in all cases, limited to the radiographs.

This table gives 55 per cent of persons over twenty years of age with one or more regions of bone destroyed about root apices as a result of a chronic infection, with an average of about one and one-half abscesses per person. In view of the generally recognized relationship between these chronic mouth infections and serious secondary manifestations elsewhere, it is imperative that dental practice be so changed as to materially reduce this high percentage of apical infections.

ETIOLOGY.

The causes of periapical infections may be classified under three headings: (1) infection through the root canal from a dead pulp caused by hyperemia or inflammation, or as a result of imperfect technic in removing the pulp or filling the canal; (2) destruction of apical fibers of the peridental membrane by medicaments placed in the root canal, or by mechanical injury to the apical tissues, such as the forcing of instruments or root filling materials through the apical foramen; (3) as a result of the death of the pulp due to infection or injury to the apical tissues, as by an extension of a chronic pericementitis beginning at the cemental line, or damage by a blow on the tooth.

PATHOLOGICAL CHANGES.

REACTION OF PERIAPICAL TISSUES. When infection from the dead pulp involves the periapical tissues, the reaction will depend very largely upon the type of the micro-organisms and the resistance offered by the tissues. If the infection is of low virulence a

*Arthur D. Black, Jnl. Amer. Med. Assn., October 19, 1918, Vol. 71, p. 1279.

slight pericementitis may develop, with a thickening of the peridental membrane, which may continue for months without serious harm to the tissues. If such an infection is too long continued, or if the organisms are such as to cause a greater tissue reaction, rarefaction of bone occurs with progressive destruction of the peridental membrane about the apex of the root, or the granulation tissue replaces the peridental membrane and resorbed bone. If the original organisms should be of a mild pyogenic variety, or if such organisms should displace those involved in the granuloma, a chronic abscess would be formed, which would also cause rarefaction of the bone about the apex of the root, and would generally destroy some portion of the peridental membrane.

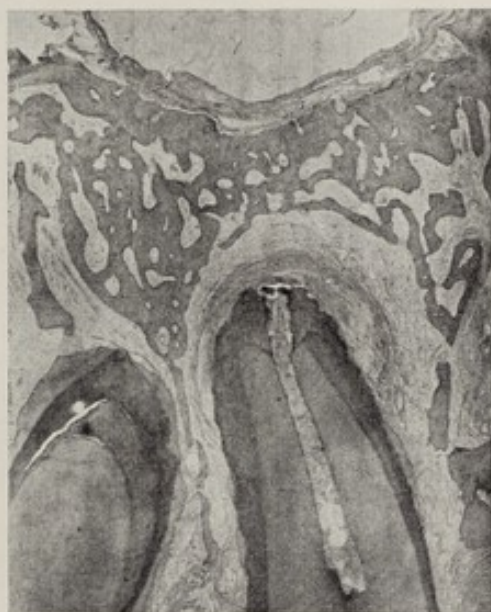


FIG. 1701. Early inflammatory reaction about apex of upper first bicuspid.

Should the initial infection be acute, there would first occur an acute pericementitis, which would pass directly into an acute periapical abscess, and if the dead pulp is not removed promptly after the acute stage is passed, the tissues about the apex will be destroyed, thus establishing a chronic abscess.

In any case of chronic infection of the periapical tissues, the proliferation of the epithelial cells of the region may form an inner layer of secreting cells, thus forming a cyst. The cyst may in turn be changed to an abscess by a pyogenic infection.

Figure 1701 is a mesio-distal section through the apices of the roots and adjacent bone of the upper bicuspids. It also shows the floor of the maxillary sinus. Only the apical portion of the root canal of the first bicuspid (on the right) is included in the section. There was a partial root filling and there is an abscess within the apical portion of the canal. There has evidently been considerable disturbance within the apical tissues with some resorption of the bone. This case may be classified as a granuloma. There may be



FIG. 1702.

FIG. 1702. Epithelial granuloma. *Th. Dependorf.*

FIG. 1703.

FIG. 1703. Epithelial granuloma. *Th. Dependorf.*

seen the beginning formation of a fibrous membrane about the apex, in which there are many epithelial cells scattered among these fibers. These do not show in the illustration. This may therefore be the beginning of cyst formation.

Figure 1702* is a section through a part of an epithelial granuloma, showing band-like strands of epithelial cells among fatty degenerated and isolated granulation tissue. In the center is an epithelial mass which is beginning to be separated from the granulation tissue.

Figure 1703* is an oblique section through the upper jaw of an adult. To the right is an abscess which is completely surrounded by a fibrous capsule, within which is a complete wall of epithelium which encloses pus and tissue debris. To the left is a softened septic focus without an epithelial covering, presenting a beginning sinus which is making its way to the surface of the mucous membrane. The root apex is to the left.

Figure 1705 shows the fibrous capsule of a chronic periapical abscess. The apex of the root was to the right of this illustration. It will be noted that there are many epithelial cells along the inner wall. These are not uncommon in the walls of abscess cavities. In

*Dr. Th. Dependorf, Zur Pathogenese der Zahnwurzelzysten. Deutsche Monatsschrift für Zahnheilkunde, 1912, p. 809.

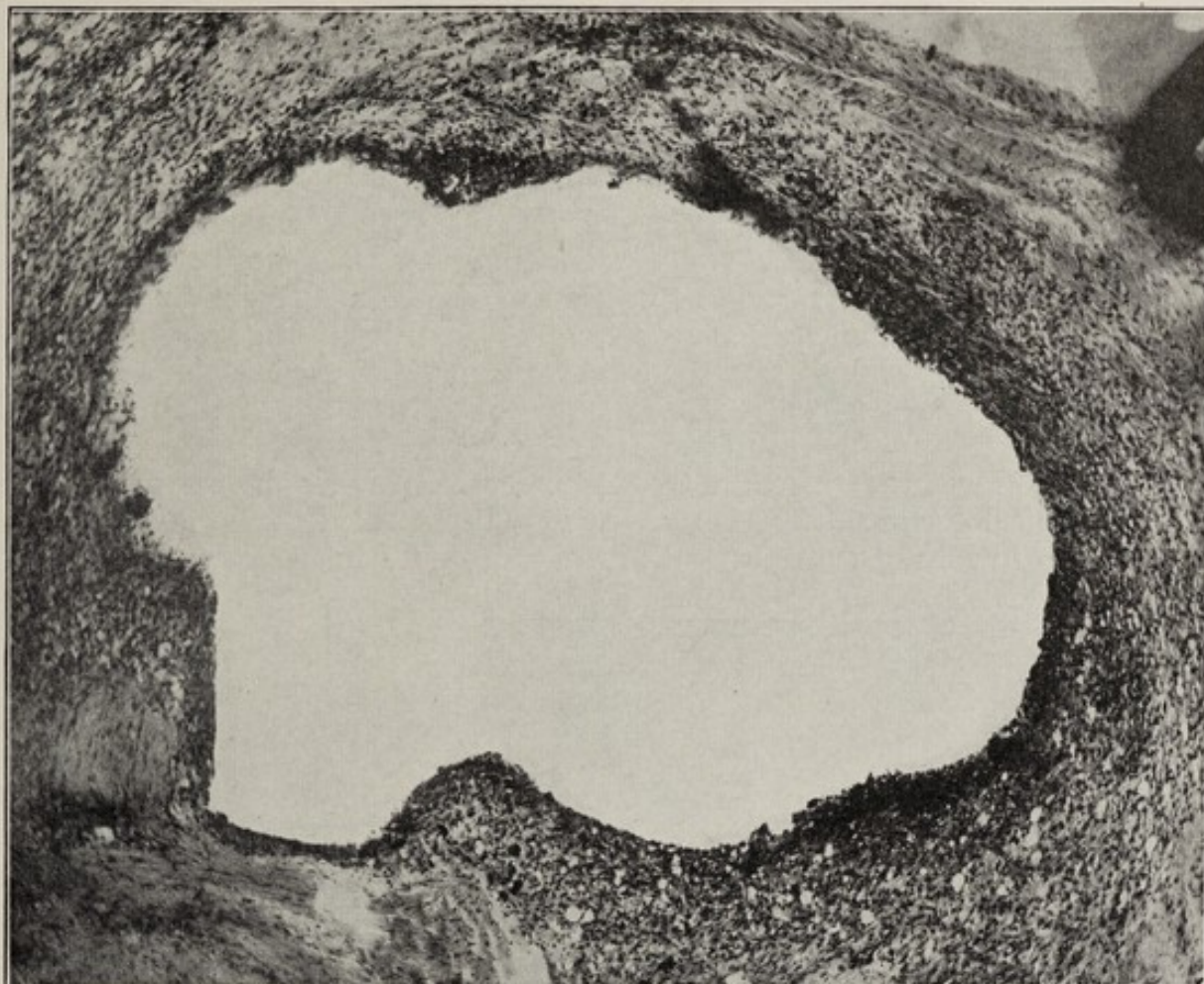


FIG. 1705. Chronic periapical abscess. Most of the cavity is lined with epithelial cells. There is a well defined fibrous tissue capsule.

fact, some epithelium is nearly always present. This might have developed into a cyst.

Figure 1707 is a section of a wall of a large cyst, showing papillomatous growth within the cyst cavity, the whole cavity being lined by epithelial cells. The walls are fibrous and contain much round cell infiltration near the cyst cavity, while the outer part is dense fibrous tissue.

PULP MAY BE DEAD, WITHOUT PERIAPICAL INFECTION. A dead pulp does not necessarily cause a periapical infection. The pulp may be dead within the canal for months or years, without apparent involvement of the periapical tissues. The rule is that periapical infection occurs rather promptly following the death of the pulp, unless the tooth is treated by removing the pulp and filling the root canal.

INVOLVEMENT OF THE PERIODONTAL MEMBRANE AND BONE ABOUT THE APEX OF THE ROOT. It must be said of the fibers of the periodontal membrane attached to the apex of the root that they show a very persistent vitality. In the beginning of acute alveolar abscess, it would seem that these fibers would be destroyed in much greater proportion than the facts indicate; generally, they are not

destroyed by the inflammation in the acute form of periapical abscesses. They seem to take little part in this process. The bone is quickly resorbed; the pus seems to seek the cancellous portion of the bone which is near by and the pus cavity is formed in this bone. Very little pus remains among the fibers of the peridental membrane, which have been loosened from their attachment to the bone. It is largely for the reason that the abscessed cavity is transferred to the cancellous portion of the bone surrounding the end of the root that these fibers escape destruction. In those cases in which the abscess cavity is not well drained during the acute stage, there is, naturally, more danger of destruction of the apical fibers of the peridental membrane.

In chronic infections of the apical region, more or less of the peridental membrane is destroyed and the cementum is denuded. This is in strong contrast to the tissue injuries in acute periapical



FIG. 1707.

FIG. 1707. Section of the wall of a large cyst.

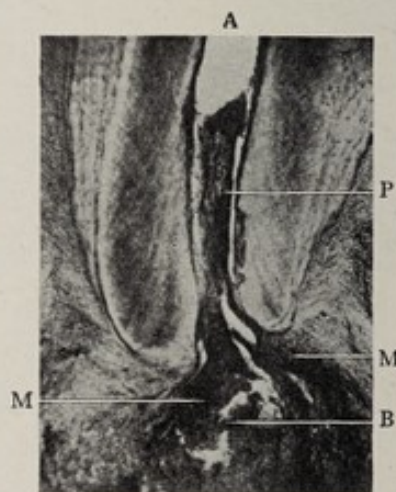


FIG. 1708.

FIG. 1708. Abscess without detachment of peridental membrane.

abscess. In practically all cases there will occur a proliferation of connective tissue from the peridental membrane, forming a wall about the infected region. This has been generally referred to as the abscess sac which will often remain attached to the root when a tooth is extracted. If one makes it a rule to examine the attachment of this tissue to the root, it will be noted that the cementum about the apex has been stripped of its peridental attachment for a distance which will correspond to the projection of the root into the rarefied region in the bone, as shown in the radiograph.

The peridental membrane is not always detached from the root. Attention has been called by Edward H. Hatton to the fact that the fibrous tissue, which forms the abscess sac, may be attached to the apex of the root immediately about the apical foramen and be folded back against the root end (as though the root

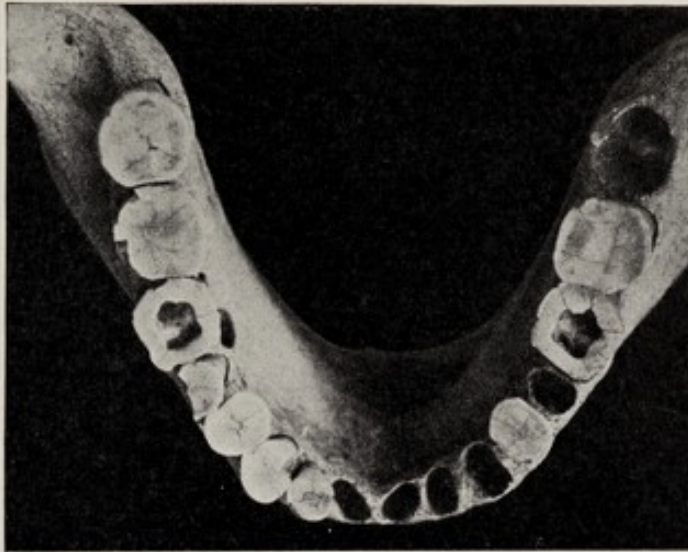


FIG. 1709.



FIG. 1710.

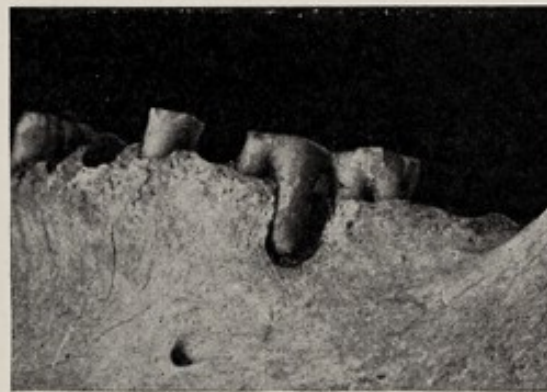


FIG. 1711.

FIG. 1709. Lower jaw of Flat-Head Indian showing open pulp chambers in both first molars.

FIGS. 1710, 1711. Right and left sides of Flat-Head Indian jaw showing destruction of bone by chronic periapical abscesses.

apex had pressed one side of a hollow rubber ball inward), without destruction of the fibers of the peridental membrane and therefore without injury to the cementum. Figure 1708 illustrates the apical region in a case in which an abscess had formed. A portion of the necrotic pulp is shown in the canal at P; a cavity containing pus at A; the center of periapical granulation tissue at B; the margin of the perivascular infiltration is at M and M. Apparently there is no detachment of the peridental membrane from the cementum. It may also be noted that the gradual enlargement of the infected region might cause the peridental membrane to be folded back without destroying it, so that the apex of the root would appear in a radiograph to be projecting into the cavity in the bone. In the case here illustrated, there appears to be no reason why the apical tissues should not make a complete recovery following the treatment of the pulp. Attention is called to the fact that a differential diagnosis between this condition and that in which the cementum of the root apex is denuded can not be made by the radiograph, as

the two might look exactly alike on the film. This does explain, however, why in rare instances, cases in which the radiograph has shown rarefaction of bone, have healed rather promptly after good root canal treatment.

Typical resorptions of the bone in cases of chronic abscess are shown in Figures 1709, 1710 and 1711. This is the lower jaw of a Flat-Head Indian from Columbia River, Oregon. The abrasion of the teeth is extensive and the pulp chambers of both lower first molars are wide open through the occlusal surface as shown in Figure 1709. This case is an anomaly in that there was, apparently, no deposition of secondary dentin. Figures 1710 and 1711 show the extensive destruction of bone about the distal roots of the first molars on both the right and left sides.

CHRONICITY CAUSED BY CONTAMINATION OF CEMENTUM. The essential feature in the pathology of the change from a pericementitis to a granuloma, or to a chronic abscess is the destruction of the peridental membrane and the contamination of the cementum about the apex of the root. This duplicates in many respects the conditions of the detachment of the peridental membrane in chronic pericementitis. The cementum dies, the detached fibers of the peridental membrane are destroyed and there is no likelihood of reattachment in either case. It is for this reason that a chronic infection of this type can never fully recover so long as the dead cementum remains.

There are two important differences in the two diseases: First, the pericemental pocket is exposed to the saliva, which permits the ingress of any and all of the mouth organisms, and also permits the escape of pus into the mouth, while the abscess is usually a closed cavity, and there is no opportunity for the escape of pus. The abscess, therefore, generally presents the danger of a toxemia, or actual metastases of bacteria via the blood or lymph channels, which is reduced in proportion to the density of its surrounding fibrous tissue wall. In cases of chronic pericementitis, there is no such limiting membrane and the infection has easier access to the lymphatic and blood systems, as is shown by the frequent involvement of the cervical lymph nodes. In some cases the periapical abscess may be directly connected with the mouth through the pulp canal and an open cavity, or there may be a sinus through the gum, either of which would reduce the systemic danger so long as there is no plugging of the root canal or closure of the sinus.

Second, the reaction of the bone is different. In cases of chronic pericementitis, in which the fibers of the peridental membrane are destroyed over a space on the side of the root, the physiological tendency is for the bone to be resorbed, because there is no longer a physiological demand for it. However, in the apical region the physiological tendency is just the opposite — the bone endeavors to build in about the apex of the root when the fibers of the peridental membrane are destroyed. This is described in connection with the illustration, Figure 1281. It is for this reason that radiographs

frequently show the rebuilding of bone destroyed by a chronic periapical infection as soon as the source of the infection is eliminated by the treatment of the root canal. However, for the region of detachment, the fibers of the peridental membrane have been destroyed, the cementum is dead and has been bathed in pus, so that there is no more likelihood of reattachment than in chronic pericementitis.

DIAGNOSIS.

The diagnosis of the several conditions will be given on the basis of histo-pathological studies, together with the possible clinical findings. Note will be made of those cases in which a differential diagnosis may not be possible. In view of the very common clinical difficulty of making a differential diagnosis between certain of these conditions, they will be considered together in some phases, except that acute periapical abscess and periapical cyst will be separately discussed later.

DEAD PULP.

The death of the pulp may usually be determined by its failure to respond to a thermal or electrical test, although these tests are more reliable in determining the vitality of the pulp by actual response to the test. Sensation may be so reduced by the building of secondary dentin that no response from a remaining vital shred of pulp tissue may be elicited, or the pulp canal may be entirely obliterated by the building of secondary dentin. The first intimation that the pulp is dead may be the discoloration of the crown, or tenderness of the tooth due to an extension of the inflammation into the apical tissues, or the discovery of a radiographic shadow indicating a rarefied region in the periapical bone. A radiograph should be made of every case in which the pulp is dead, to determine, if possible, whether or not the periapical tissues may be involved, and to what extent. The differential diagnosis between simple pulp death and the death of the pulp complicated with destruction of periapical tissues, may be the deciding factor between the conservation and extraction of the tooth.

TRAUMATIC APICAL PERICEMENTITIS.

The periapical tissues may be inflamed as the result of an injury, such as a blow on the upper incisor teeth, or excessive occlusal stress in mastication. In either case the pulp may be vital, although the injury to the periapical tissues may be sufficient to cause its death. The tooth will be tender to pressure, particularly in the direction of its long axis. There may be no pain, or the degree of pain will depend upon the extent of the injury. The radiograph may indicate some destruction of bone, resulting from a severe blow on the tooth, or it may show either slight resorption or condensation of bone in the apical region due to excessive occlusal stress over a considerable period of time.

ACUTE APICAL PERICEMENTITIS.

An acute inflammation of the periapical tissues may result from an extension of a pulpitis. The tissues may recover without damage if treatment is instituted promptly; they may become infected and a chronic or an acute periapical abscess may result. In apical pericementitis the tooth will usually be tender to pressure and it may be slightly elevated in its socket. There may be slight pain at first, which will disappear or become more severe, according to the changes which occur in the tissues.

CHRONIC APICAL PERICEMENTITIS.

When the periapical tissues are first involved in infection from the dental pulp, there may occur a mild type of very low grade infection which causes an inflammation of the peridental membrane of the immediate neighborhood without doing permanent damage to the tissues. Cellular infiltration of the tissue will occur and the peridental membrane may therefore become more dense and possibly thicker, while the adjoining bone may be resorbed. The essential difference is that there is no actual detachment of the peridental membrane from the cementum. There may be no showing of this condition in a radiograph, as the involvement of the bone is likely to be slight. The tooth may be tender to pressure and a vitality test of the pulp will indicate that it is dead. If the dead pulp is removed, complete recovery should follow promptly.

CHRONIC PERIAPICAL ABSCESS. GRANULOMA.

It is usually impracticable to make a clinical differential diagnosis between a granuloma and an abscess, and this is of no particular importance, as the treatment of both conditions is the same. There may be no clinical symptoms of either condition, although either may have existed for months or years, and the radiograph may be the principal and oftentimes the only means of diagnosis. There may be a history of injury, of an acute abscess, or of pulp removal and root filling. The tooth may be tender to pressure or it may be loose. Sufficient bone may have been destroyed that palpation with a finger on the gum over the position of the root apex will reveal a very thin outer plate that will give a little under pressure, or a little of the outer plate may be missing. Pus may or may not be present; there may be a sinus discharging through the gum or externally on the face or neck. The discharge may be constant or intermittent, with the orifice closed between the periods of discharge. If the abscess communicates through the pulp canal with an open cavity in the tooth, pus may be discharged by that route. The abscess cavity is often entirely closed — a "blind" abscess. The presence of pus constitutes the differential diagnosis between a granuloma and an abscess.

Radiographic examination. In cases in which sufficient bone has been destroyed to be definitely recorded on the radiographic

film, a diagnosis may usually be made, although a differentiation between granuloma and abscess is not possible unless the presence of pus is demonstrable by exploration through the root canal or through the gum. Figure 1712 shows a small rarefaction at the apex of the root of a lower central incisor in which the pulp had died, probably from a blow, and had gone unnoticed by either patient or dentist until the radiograph was made. Figure 1713 shows a rarefaction at the apex of the mesial root of a lower first molar. There is some hypercementosis, and apparently considerable reduction in the size of the root-canals by secondary dentin. Some bone has been resorbed from the bifurcation of the roots of both the first and second molars, also between the root of the second and third molars. In this case both the first and second molars were extracted. Figure 1714 illustrates a failure to fill the root canals of an upper first bicuspid, also the rarefaction of the periapical bone. The outline of the bone cavity is usually somewhat indefinite on the film in cases of granuloma or abscess, and rather



FIG. 1712.

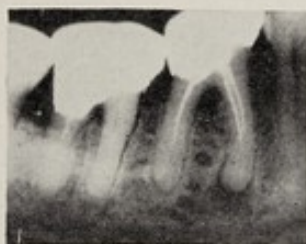


FIG. 1713.



FIG. 1714.

FIGS. 1712, 1713 and 1714. Three illustrations of chronic periapical abscesses.

definitely rounded with a smooth outline, when cysts are formed. If the apex of the root appears to be projecting into the cavity, it may be assumed that the peridental membrane has been destroyed over that portion of the root, although, as previously mentioned, an occasional case has been reported in which it has remained intact. See Figure 1708. In cases in which there is some question whether there has been actual destruction of bone, the best judgment may be formed from observation of the plate of bone to which the fibers of the peridental membrane are attached—the lamina dura; if the white line on the film, parallel and close to the surface of the root, is continuous about the apex, it signifies that the fibers of the peridental membrane are intact, also that none of the bone immediately about the apex has been destroyed. In many cases, radiographs should be made from several different angles in order to observe the largest possible amount of bone about the apex. The line is not always clearly visible about the root ends when conditions are normal, therefore its absence does not necessarily indicate bone destruction.

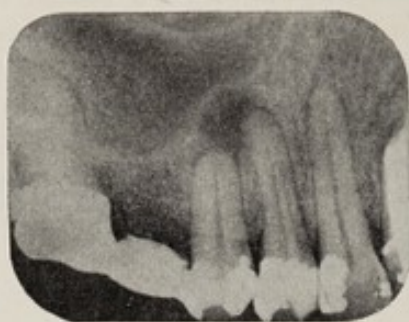


FIG. 1715.

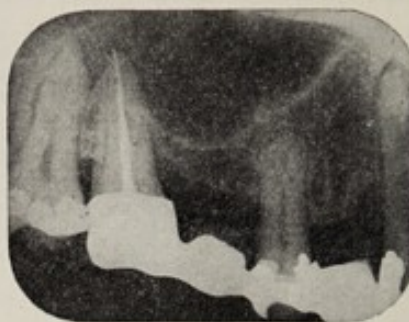


FIG. 1716.



FIG. 1717.



FIG. 1718.



FIG. 1719.

FIGS. 1715 to 1719. Radiographs which emphasize the necessity of accurate interpretation. See text.

In an occasional case, the shadow cast on the film by the rarefied region may make it appear that two teeth are involved in a given abscess, instead of a single tooth. Radiographs of such a case are shown in Figures 1715 and 1716. In this case two bicuspid appeared to be equally involved, although the pulp of one was vital. In Figure 1717 the mental foramen is shown below the roots of the lower bicuspid. It may often cast a shadow about the apex of either root. It is difficult and sometimes almost impossible to show on a film the exact conditions about the roots of the upper molars. Figures 1718 and 1719 illustrate a case in which a rhinologist had ordered an upper first molar (with a vital pulp) extracted on account of a shadow in the maxillary sinus. The shadow did not show in a film taken at a slightly different angle.

Cases are seen occasionally in which the peculiar structure of the bone suggests a rarefied region about a root apex when the pulp is vital. Also when the apex of one or more roots of lower second or third molars may slightly overlap (on the film) the mandibular canal, the canal may appear to be wider than elsewhere, as though some bone had been resorbed. The bending of the films in placing them in the mouth occasionally results in confusing distortions. All such conditions should be checked with pulp vitality tests.

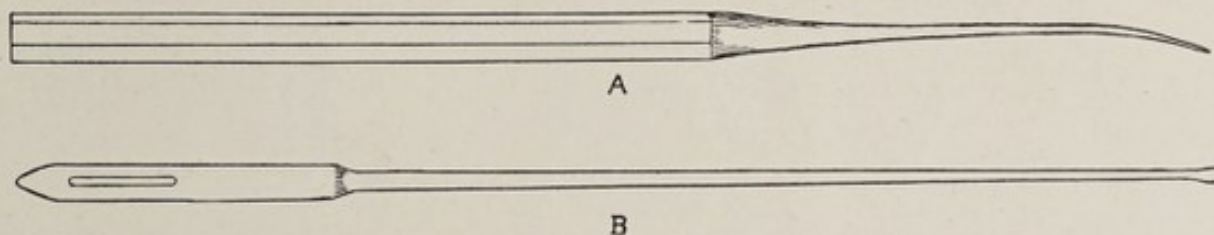


FIG. 1720. Sharp steel probe and blunt silver probe.

Sharp steel probe. A sharp steel probe may be passed through a sinus, or through the gum, and in some cases through the bone, into the bone cavity and the extent of the rarefied region may be fairly accurately determined. A sharp steel probe and a blunt, flexible silver probe are illustrated in Figure 1720.

Examination through root canal. An opening through the crown of the tooth may reveal a dead pulp. Pus may be present in the root canal or may discharge into the canal if a broach is passed through the apical foramen. If no pus is discovered in such an examination, or by probing through the gum, a granuloma, rather than an abscess is the more probable condition.



FIG. 1721A.

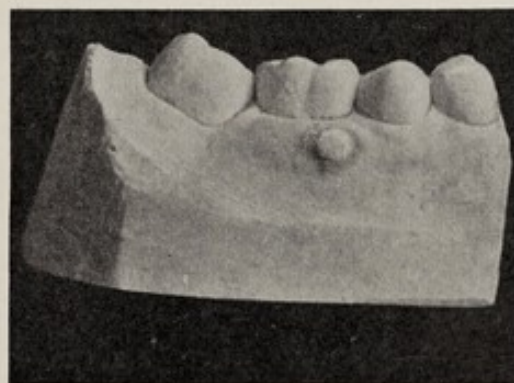


FIG. 1721B.

FIG. 1721. Photographs of plaster model of a case of chronic abscess with intermittent discharge.

VARIATIONS IN POSITION OF SINUS OPENINGS. While the opening of the sinus will usually be immediately over the root of the diseased tooth, this is not always the case. See the sinus opening from an abscess from a lower first molar in Figure 1721. Occasionally the discharge will be at the gingival line, the peridental membrane having been detached, so as to form a sinus alongside the root.

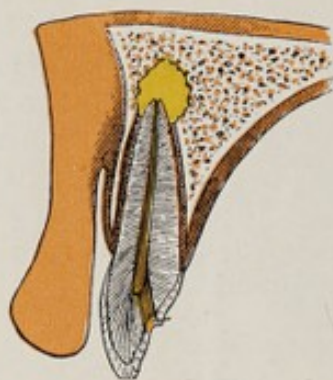


FIG. 1722.

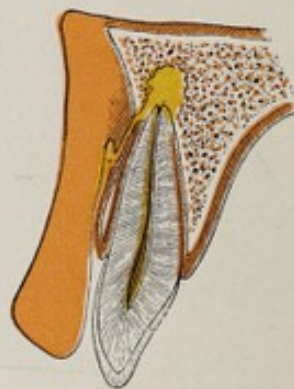


FIG. 1723.

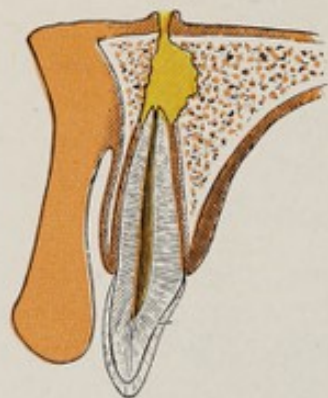


FIG. 1724.

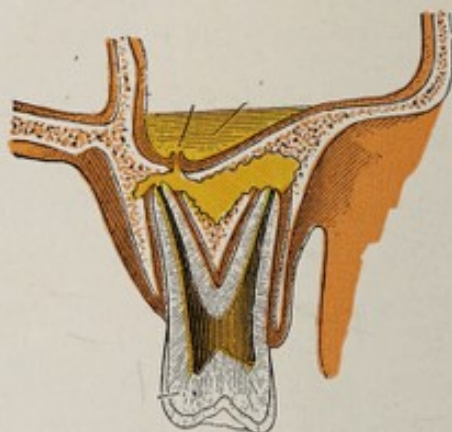


FIG. 1725.

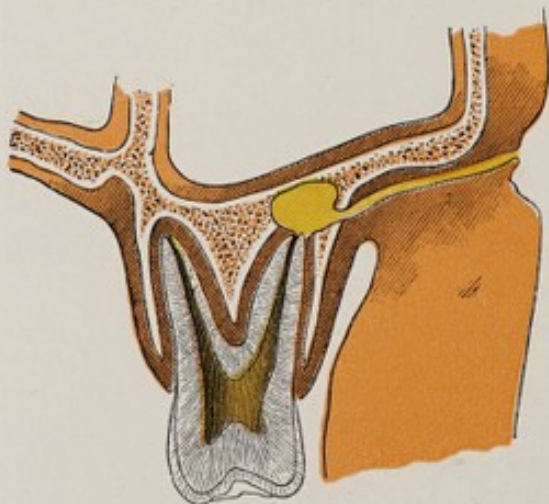
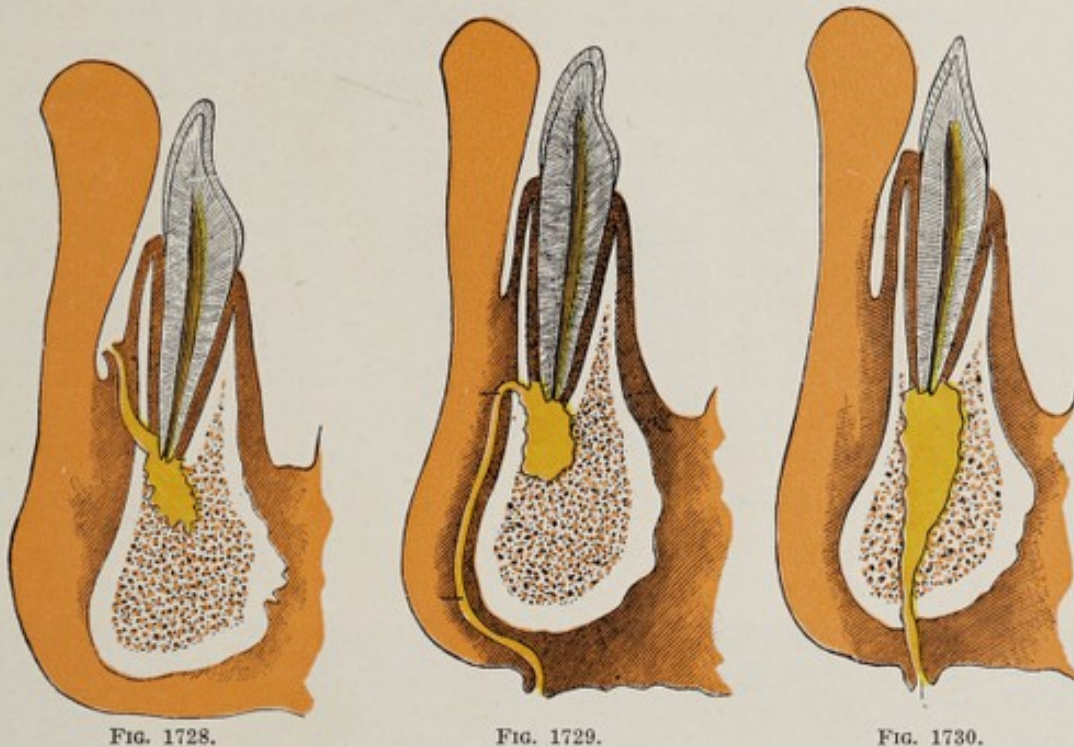


FIG. 1726.



FIG. 1727.

FIGS. 1722 TO 1727. Various types of chronic periapical abscesses, with routes of discharge, from upper anterior teeth and upper molars.



FIGS. 1728 TO 1730. Various routes of discharge from chronic periapical abscess from lower anterior teeth.

Figure 1722 is a blind abscess at the apex of the root of an upper central incisor. The drill hole for the removal of the pulp has been made through the lingual surface of the tooth. Figure 1723 shows an abscess from an upper incisor which is discharging through a sinus opening on the gum. Figure 1724 shows a similar abscess discharging into the floor of the nose. In Figure 1725, the discharge is from an upper molar into the maxillary sinus, and in Figure 1726 there is a discharge on the face from the buccal root of an upper molar. The scar that such an abscess might make is shown in Figure 1727. Figures 1728, 1729 and 1730 illustrate three different routes of discharge from a chronic abscess from a lower incisor or cuspid. In Figure 1728 the discharge is through the gum, while in Figure 1729 through the labial plate of the bone and then via a sinus through the soft tissues opening under the chin. In Figure 1730 the route is directly through the bone at the lower border with its exit under the chin.

Sometimes the sinus may be long and tortuous. A case is recalled in which the opening was through the gum exactly over the root of a lower left cuspid. This tooth gave a positive response to heat, as did the other front teeth, and as both bicuspid and the first and second molars had been extracted, the dentist had not been able to determine the cause of the abscess. A probe followed this sinus distally to the root of the third molar.

Sinuses are seen less frequently in recent years than formerly for the reason that a much larger number of teeth with chronic abscesses are discovered early, through the use of the radiograph in making examinations. The majority of cases are a result of the neglect of dead pulps.

An extreme example of the relation of the apices of the roots of the upper second bicuspid and upper first and second molars to the maxillary sinus is illustrated in the radiographic reproduction in Figure 1731.



FIG. 1731. Radiograph showing very thin bone of floor of maxillary sinus about roots of upper molars.



FIG. 1732.

FIG. 1733.

FIG. 1734.



FIG. 1735.

FIGS. 1732 to 1735. Deposits of serumal calculus on roots in cases of chronic periapical abscess.

DEPOSITS OF SERUMAL CALCULUS. Whatever portion of the cementum is denuded of its periodontal membrane may receive a deposit of serumal calculus. Such a deposit occurs under conditions similar to those under which serumal calculus is deposited on the cementum of pockets resulting from inflammations of the gingivæ. See Figures 1732, 1733, 1734 and 1735.

BACTERIOLOGY. In a report* made by Dr. Thomas L. Gilmer in 1914 on the bacteriology of acute and chronic periapical abscesses the streptococcus was the predominating organism, although there were "many graded variations from a hemolytic streptococcus, with a wide range of hemolysis in the acute abscesses, to a streptococcus viridens in the chronic." The streptococcus viridens appears to be practically always present in the chronic abscesses.

*Journal American Medical Association, 1914, Vol. LXIII, p. 2023.

Treatment of Chronic Periapical Infections

In view of the fact that chronic periapical infections are always associated with conditions within the root canal, it seems desirable to consider both the treated canal and the dead pulp, together with the periapical condition, in determining the treatment. In view of the generally recognized relation of infections of the periapical region to systemic disease, and the evident belief of some dentists and physicians that *all treated teeth* should be extracted, the so called "x-ray negative" tooth will be included in this discussion. The various conditions will be considered from the viewpoint of the dentist who is examining a number of patients and desires to eliminate all infected foci, and this discussion of the treatment will be in part a further discussion of the diagnosis.

COURSES OF PROCEDURE. With all available evidence at hand, a decision must be reached to follow one of four courses of procedure: (1) To consider the condition safe and retain the teeth, in cases in which the root canal appears to be well filled and there is no evidence of disease about the apex of the root; (2) to remove the root canal filling and retreat the canal in cases in which it is apparent that there was some technical error in the treatment of the pulp or root canal, and the periapical conditions are such that a full recovery seems probable or possible; (3) to resect the root, or amputate the root of a multi-rooted tooth, in those cases in which the condition of the surrounding bone seems favorable and there appears to be no question as to the destruction of the peridental membrane of the periapical region; (4) to extract the tooth in cases in which there has been destruction of the periapical tissues and the resection of the root is not indicated.

TEETH THAT SHOULD BE RETAINED.

It should be the rule that teeth should be retained in cases in which the root canal appears to be well filled and there is no evidence of disease about the apex of the root. The decision should be reached only after the most thorough examination and analysis of the conditions. This should never be done on the basis of the radiograph alone, but should include a critical examination of the mouth, together with the patient's history of the case and his report of possible symptoms.

RADIOGRAPHS. The radiographs should be as perfect as may be made and their interpretation should include careful consideration of all matters mentioned in connection with radiographic diagnosis. The author's experience with cases referred by both physicians and dentists indicates that a large percentage of dental films show so little of accurate detail as to be worthless when exactness of interpretation is necessary. This statement applies in the main to films taken by dental practitioners and by general radiographers, particularly many of those employed by hospitals, who have apparently not had sufficient training in the technic of making dental

films. It does not apply to those expert dental radiographers, whose interest and experience in the development of this field has made their work indispensable, nor to a limited percentage of dental practitioners who have trained themselves thoroughly.

A splendid resume of this question of the retention or removal of the so called X-ray negative teeth is presented in the special chapter in this volume by Edward H. Hatton, and it will suffice to make only a few brief statements here. A fair analysis of the evidence seems to justify the following statements:

Poor radiographic films have been too often used in arriving at the decision that a tooth was x-ray negative, and many that were so classified, were doubtless x-ray positive. To arrive at a decision that the periapical tissues are x-ray negative, one should be able to see in each case chosen for such a study, the lamina dura continuously from one side of the root about the apex to the other side. As has been mentioned, the absence of this line does not necessarily indicate that there has been infection in the apical region, because the line may not always be observed about a tooth with a vital pulp. However in any special study of treated teeth which are to be listed as x-ray negative, only those in which the lamina dura does show should be used. Lack of differentiation between teeth with apparently well filled root canals and those with definitely imperfect fillings, in the selection of cases for study, has added a considerable element of error. The fact has been overlooked that an x-ray negative tooth, so far as the showing of the bone is concerned, may have infected pulp tissue remaining within the apical end of the canal. Such a tooth should be classified as an imperfectly treated tooth, and there might be an apical pericementitis which would be cured by proper treatment of the root canals. As a matter of fact, an x-ray negative tooth may be a tooth with the enamel intact and the pulp dead, which suggests that every tooth which does not have a root filling should be tested for vitality, when the greatest accuracy is required.

UNRELIABILITY OF BACTERIOLOGICAL EXAMINATIONS. It is extremely difficult for the most expert bacteriologist to so direct the removal of a vital tooth that cultures from such a tooth may not be obtained of the same organisms as are found in apical abscesses or the fluids of the mouth, which discounts much of the bacteriological evidence presented in recent years.

In a recent paper,* Fish and Maclean report experiments on the invasion of the tissues by mouth streptococci and their toxic products. They state that "it is generally recognized that streptococci and a variety of other organisms may regularly be grown from the roots of extracted teeth, even though such teeth have living pulps." They also say: "it has been shown by R. S. Taylor, Ellingham and others that organisms may be cultivated from the live pulps of these extracted teeth. The accumulated evidence of

*The Distribution of Oral Streptococci in the Tissues. Brit. Den. Jnl., Vol. 61, 1936, p. 336.

the presence of these organisms is so great that it would appear to be irrefutable, and yet the periapical tissues and the pulps of ordinary live teeth are always found histologically to be free from any sign of irritation such as would inevitably be seen if mouth streptococci were present. The only conclusion seemed to be that the organisms get there during extraction and so arrive too late to set up any reaction." Continuing, they make the further statement that when teeth with vital pulps and pockets caused by chronic pericementitis were extracted, such teeth could only be delivered with sterile roots and pulps by a previous sterilization of the pocket with the electric cautery. The controls were always infected when the pockets were not sterilized; photomicrographs of these teeth show streptococci and diplococci in the blood and lymph

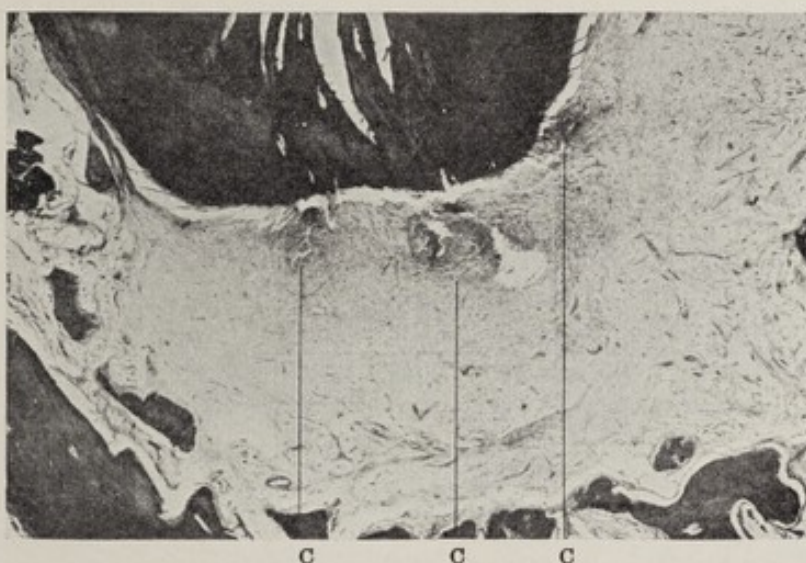


FIG. 1736. Apex of dog's canine experimentally infected and excised in situ. There are three centers of cellular infiltration at the openings of the accessory canals, C, C, C. The cellular infiltration and therefore the diffusion of the toxic matter, diminish as the distance from the organisms in these centers increases. Organisms were visible in the canals under higher magnification. E. Wilfred Fish and I. Maclean, *British Dental Journal*, Vol. 61, 1936, p. 336.

vessels and lymph spaces. It is shown that they are "pumped" into these vessels via the peridental membrane in the ordinary manipulation of the tooth in extraction.

It is further stated that "in the case of infected dead teeth the infection is confined to the root canals or the pus of an associated abscess. The surrounding bone and soft tissues are sterile, though irritated by diffusible toxic products."

The accompanying illustration, Figure 1736, is reproduced from paper by Fish and Maclean. It shows "the apex of a dog's canine experimentally infected and excised in situ. There are three centers of cellular infiltration at the openings of the accessory canals, indicated by C, C, C. The cellular infiltration, and therefore the diffusion of toxic matter, diminishes as the distance from the organisms in those canals increases. Organisms were visible in the canals under higher magnification."

Illustrations of the lymphatic and blood vessels in the peridental membrane are shown in Figures 1267 and 1268.

STUDIES BY PHYSICIANS AND DENTISTS. Many physicians and bacteriologists who have studied these cases have apparently been handicapped by lack of intimate knowledge of dental conditions, and in some instances appear either not to have sought the advice of an experienced dental research worker, or have been ill advised by some dental friend who was not himself sufficiently acquainted with the various angles of this complex problem.

Too many physicians have classed the teeth with the tonsils as being of no particular value to the individual and have ordered teeth extracted with great abandon. It is wrong in principle for a physician to decide that teeth should be extracted, and there is ample evidence that those who assume that responsibility make many mistakes. Each physician should seek and find a reliable dental confrère to whom he can refer these cases.

TEETH THAT SHOULD BE RETREATED.

In cases in which there is not a definite rarefaction in the periapical bone, and the root filling does not completely fill the canal in the apical portion of the root, the root filling should be removed, the canal should be aseptized and refilled. The root canal filling may be imperfect in that it does not reach to the apex and an unfilled portion of the canal can be seen; also the filling may extend fully to the apex and yet be smaller than the caliber of the canal. In this connection attention is called to the study of root canal fillings reported in the section on the technic of treating root-canals. The fillings in large canals were listed separately from those in small canals; the fillings were also classified as good or poor fillings depending upon whether or not the apical end of the canal was well filled. In this latter classification a root filling in a small canal was considered good, even though it did not reach the apex, provided the canal from that point to the apex could not be seen in the film with a magnifying glass. Of the 343 teeth with good fillings in large canals, 31, or 9%, were abscessed, of the 184 good fillings in small canals, 19, or 10% were abscessed.

In cases in which a gutta-percha cone is pushed through the apical foramina, the effort should be made to remove the filling. The majority of cases of this type are those in which an abscess apparently existed at the time the root filling was made; in some the overfilling doubtless caused the abscess. A root resection should be considered in these cases.

RESECTION OF ROOTS. In those cases in which the cementum at the end of the root is denuded, the abscess may often be cured by resecting the root. This operation should be confined to the upper incisors, cuspids, buccal roots of first bicuspid, and buccal roots of the upper molars, and occasionally the lower incisors. Resection of other roots is contraindicated by the greater depth of bone which must be penetrated, making the operation more difficult, and the results have generally been unsatisfactory, even when a good operation has been performed.

Technic. The technic of the operation is simple. Under local anesthesia a curved incision from one-half to three-fourths of an inch long should be made through the soft tissues over the root, the convexity of the curve being toward the crown of the tooth. The tissue on the concave side of the cut should then be raised in the form of a muco-periosteal flap, and held with a small retractor or other instrument.

The bibeveled drill is then used to cut away sufficient bone to give access to the apex of the root. Except in cases of blind abscess, it will generally be necessary to do very little cutting in the bone, as the labial or buccal plate will usually have been destroyed already. The root may be cut off by drilling a hole through it with a bibeveled drill, and then cutting laterally in both directions from this hole with a fissure bur. The fissure bur quickly fills with the cuttings, and is objectionable on this account for drilling the hole. There is no clogging of a bibeveled drill. After the apex of the root is removed, the end of the remaining portion should be made smooth and slightly rounded.

In cases in which only a very little of the apex of the root is denuded, a large fissure bur may be used to trim off the end, without removing a definite piece. In each case, all that is required is to remove the denuded portion, and leave the remaining end smooth. This should be followed by irrigation to remove the debris and cleanse the cavity, a dressing sometimes being employed to permit healing from the deepest part.

Possibilities of healing. One might think of the conditions presenting as to the healing of the tissues over such a root end, as being identical with those of a pocket resulting in a detachment of the peridental membrane beginning at the gingival line, but the two are not quite parallel. In the case of the resected root, it is a matter of a few days at most until the root end is entirely enclosed within the tissues and completely shut off from the fluids of the mouth, so that a reinfection is very much less likely to occur.

There are three possibilities of healing: (1) In the absence of infection the tissues may attach themselves to the root end; (2) the cementoblasts from the sides of the root may gradually build new cementum over the end; (3) the tissues may simply heal over the root end, without being attached to it, the same as they might heal around a foreign body.

Radiographs are reproduced of four cases of root resection. Figure 1738 shows an upper central incisor with a gutta-percha root-filling that had been pushed through the apex into a small rarefied region in the bone. The root was resected in 1930. Figure 1739 is from a radiograph taken five years later, during which time the tooth had been in normal use without discomfort. The bone appears to have filled in perfectly. The operation of resecting this root was performed by E. Mueller.

Figure 1740 is a reproduction of a radiograph of an upper lateral incisor taken in 1929, immediately after the root was resected in treatment of a chronic abscess, for a patient 32 years of age, by Charles W. Freeman. Figure 1741 shows the condition six years later. Figure 1742 shows the condition of another case of resection of an upper central incisor taken four years after the operation, and Figure 1743 was taken about twelve years after an upper lateral incisor was resected by the late Dr. Thos. L. Gilmer.



FIG. 1738.



FIG. 1739.



FIG. 1740.



FIG. 1741.

FIGS. 1738, 1739. Resection of upper central incisor root.

FIGS. 1740, 1741. Resection of upper lateral incisor root.



FIG. 1742.



FIG. 1743.

FIG. 1742. Resection of upper central incisor root.

FIG. 1743. Resection of upper lateral incisor root.

A very unusual case* of a repair of cementum is illustrated in Figure 1744. A dentist, in an attempt to extract a lower first molar for a girl fifteen years of age had broken off the crown and a part of the root, leaving the remainder of the root in its socket, and the gum closed over the root. Four years later the root was removed, the soft tissues were found to be adherent, presumably, to the broken surface of the dentin. The root was sectioned and it was then discovered that cementum had built over the exposed dentin and had filled in the pulp chamber, also peridental membrane fibers were firmly attached to the cementum. In the illustration, the dentin is D, D; the cementum, C, C, C, C, C; and the peridental membrane P-D.

*M. H. Fletcher, Dental Summary, Vol. 31, 1911, p. 603.



FIG. 1744. Repair of Cementum. See Text. Description: d, dentin; p, pulp; c, cementum; pd, periodontal membrane." M. H. Fletcher, *Dental Summary*, Vol. 31, 1911, p. 601.

It should be stated that some cases of root resection do not do well. The root end may cause sufficient irritation to keep up a slight discharge and the opening through the gum may not entirely heal. Or, if it does heal, the irritation causes the constant outpouring of slight quantities of serum and a pocket remains about the root end. In either case the elements for the reproduction of the chronic abscess are present, and sooner or later, the tissues will become infected. All cases in which roots are resected should be carefully watched, and within a year a radiograph should be taken to learn the condition, even though the tissues appear to be in good condition. The cases which do not succeed can be cured by extraction.

AMPUTATION OF MOLAR ROOTS. When a chronic abscess involves but one root of a molar, the diseased root only may sometimes be amputated. This operation is more often indicated for lingual roots of upper first molars, and less often for either root of a lower first molar. The technic of the operation has already been given in connection with the treatment of suppurative pericementitis. In cases of abscess, more or less of the periodontal membrane remains attached between the abscess and the cemental line, so that the position of the bifurcation of the roots, their general contour, etc., is not so easily determined as in cases of suppurative pericementitis. See Figures 1517 to 1522.

TEETH THAT SHOULD BE EXTRACTED.

When it may be judged that the periodontal membrane has been destroyed about the apical portion of the root, and the case is not one that seems favorable for root resection or amputation, the tooth should be extracted. Particularly when the apex of the root appears to project into the cavity in the bone, which is an almost certain

indication that the apical cementum is denuded, the removal of the tooth is in order. The possibility that the peridental membrane might be folded back, as mentioned in connection with Figure 1708, seems to be too slight to deserve consideration except occasionally in the mouths of comparatively young persons. One who examines the extent of the denuded cementum of teeth extracted on account of apical infections will practically always find that the region of denuded cementum corresponds with the bone rarefaction as shown in the film.



FIG. 1750.



FIG. 1751.



FIG. 1752.



FIG. 1753.

FIGS. 1750 to 1753. Rebuilding of bone in chronic periapical abscess.

One case is illustrated in which the apex of the root appeared to project into a cavity in the bone and yet the effort was made to cure the abscess by removing the pulp and filling the canal. Figure 1750 is from a radiograph taken on April 4, 1932, of an abscessed upper lateral incisor, at the time the root filling was made. Figure 1751 shows the condition of the bone on November 7, 1932, and Figure 1752 on December 13, 1933 and Figure 1753 on December 14, 1934, three years and eight months after the root filling. The lamina dura is not present on the distal side of the root in Figure 1753 and the prognosis is that this tooth must eventually be extracted. It is one of a number that are being studied.

Teeth with apparently normal bone about the apices, which are slightly loose, tender to pressure, or are occasionally a little "too long" and there is a history of having had an acute abscess, or if the patient complains of occasional aches and pains which are limited to the distribution of the fifth nerve on the same side, and particularly if these symptoms have prevailed for some months, the teeth should generally be removed, as any one of many combinations of these symptoms suggest a low grade infection.

As has been stated, when a patient is seriously ill of some disease which might be caused or complicated by a local focus, and other regions have been eliminated, as far as they may be, as possible causes, it is the dentist's duty to be certain that the cause is not in the mouth, even though this requires the removal of treated teeth which appear to be without infection.

PERIAPICAL CYST. RADICULAR CYST. ROOT CYST.

This condition may result from a traumatic pericementitis, from a granuloma or a chronic periapical abscess. The proliferation of epithelial cells from the peridental membrane form an inner lining membrane of the granuloma, and secrete a clear fluid. These cysts are painless, although there may be some tumefaction, due to the gradual enlargement of the cyst by the pressure of accumulated fluid within, which may push the bone, teeth and soft tissues out of position.

As a rule, there are no subjective symptoms. In occasional cases the patient may notice the very gradual, though painless, tumefaction, resulting from the pressure of the cyst on the outer plate of the bone.



FIG. 1754. A lower maxilla showing a smoothly rounded cavity, evidently made by a cyst.

The diagnosis may usually be made from the radiograph, as the outline of the cyst is regular and sharply defined from the surrounding bone. The discharge of cystic fluid through the root canal or through a gum incision is positive evidence. The cyst fluid should be examined for cholesterin crystals.

A periapical cyst may persist indefinitely after the extraction of the tooth, if the cyst wall is not removed.

In discussing the histological structure of the peridental membrane, attention was called to the chains and clusters of epithelial cells which are found lying close to the cementum, and reference was made to the possible functions of these cells. These are illustrated in the section shown in Figure 1270. They apparently multiply in response to irritation and infection and find their way into granulomas. Periapical cysts enlarge very slowly as a result of the gradual increase in their fluid content, and they cause pressure resorption of the surrounding bone and frequently force roots out

of position. Usually they are not larger than a filbert, although they may become several times that size. The bony wall may be more dense than the surrounding bone. After a time, the smaller cysts may show the opposite tendency and become progressively smaller until they are eliminated.

Figure 1754 is from a photograph of a mandible showing a smoothly rounded cavity, evidently made by a cyst. Figures 1755 and 1756 are from radiographic prints of two cysts of moderate size, while the cyst shown in Figure 1757 is considerably larger, having caused resorption of bone about the upper central and lateral incisors and the cuspid.



FIG. 1755.



FIG. 1756.



FIG. 1757.

FIGS. 1755, 1756, 1757. Radiographs of periapical cysts.



FIG. 1758.



FIG. 1759.



FIG. 1760.

FIG. 1758. Cyst that was probably mistaken for an abscess at the time the tooth was extracted.

FIG. 1759. Radiograph of a case of a cyst of the lower jaw, boy twelve years old.

FIG. 1760. Radiograph of a case of a cyst in the upper bicuspid region. The apices of the bicuspid roots have been forced apart by the pressure exerted by the cyst.

Figure 1758 shows a cyst in the position of the lower third molar. This cyst was doubtless presumed to be an abscess when the tooth was extracted and it is now a completely closed cavity, not associated with a tooth root. It probably would have continued to enlarge, if it had not been discovered and enucleated. Two additional cysts are shown in Figures 1759 and 1760.

TREATMENT. The treatment of cysts consists of their complete elimination, by the discharge of the contents and the enucleation or obliteration of the lining membrane. The obliteration may be by cauterization, although the most certain method is by a surgical operation, thus enucleating the membrane.

The operation should be performed under local anesthesia. A semicircular incision through the muco-periosteum is made with

the convexity toward the crown of the tooth, and a flap is raised. If necessary, a portion of the bony wall is then cut away to expose the cyst and an incision is made through the cyst wall. The region should be packed with gauze to prevent the cystic fluid from coming in contact with the tissue. The wall consists of a dense fibrous membrane and it is usually possible to grasp it with a pair of sharp toothed pliers and peel it out, oftentimes in a single piece. If any portion of the wall is left, the cells may multiply and reform the cyst. Therefore, if there is any question as to its complete removal, the cavity should be cauterized and a dressing should be employed to keep the cavity open, while it heals from the deepest part. It may be expected that the bone will eventually regain its normal contour.

In treating the larger cysts, the Partsch operation may be preferred. After making a large opening through the buccal or labial wall of the cyst, the muco-periosteal flap is sutured to the lateral walls of the cyst cavity so that the cyst wall is thus continuous with the mucous membrane of the mouth. This eliminates the necessity of enucleating the cyst lining and is as though the inner wall had been covered with granulation tissue and this in turn with epithelium.

CHRONIC OSTEITIS.

Chronic osteitis* may be defined as death of bone, cell by cell. Chronic osteitis differs so widely from necrosis of bone that it must be considered an entirely separate disease. It is a condition of inflammation and disintegration which is progressive in its character; the bone is disintegrated cell by cell, instead of being destroyed *en masse* as in necrosis. It shows a very decided disposition to continuous slow progress, attacking and softening the bone to which it makes approach, often hollowing out the cancellous portions of large areas of bony tissue. This portion of the bone is seemingly preferred by this process, although upon occasion it will change the structure of the hardest bone.

The etiology of this condition has never been clear, but it was thought by the late Thomas L. Gilmer to be a sequella of neglected or undiscovered cases of other types of periapical infections, particularly the blind abscess. Since the advent of the radiograph and the general interest of both dentists and physicians in the eradication of these infections, the incidence of chronic osteitis has been reduced to the point where it is infrequently seen in private practice.

It is a rather curious fact that chronic osteitis most frequently occurs in the incisor region in the maxillae and very seldom in the mandible. A large percentage of cases has occurred about the roots of upper lateral incisors, possibly for the reason that the pulp

*In dental literature, this condition has been commonly referred to as caries of bone. The word caries was formerly applied in surgery to a cellular destruction of bone caused by tuberculosis, actinomycosis or syphilis. The condition of the maxillary bones here described is similar, but seems not to result from the causes mentioned.

of this tooth is so frequently involved in hyperemia and inflammation.

SYMPTOMS. There may be no pain and little, if any, swelling in cases of chronic osteitis. The temperature will seldom exceed one degree above normal. The subjective symptoms are so slight that cases will often run for years without attracting the patient's attention. There may be a little discoloration of the overlying gum tissue. A close examination may reveal one or possibly several very minute sinuses, about the openings of which there may be small rings of granulation tissue. The openings may be so small that they will be discovered most readily by making pressure with a finger on the gum and noting the discharge through them.

The discharge from cases of chronic osteitis is usually very slight in amount, and of a pale yellow or straw color. Unless contaminated with saprophytic organisms which produce decompositions, there is little or no odor. The pain, if any, is slight, but when a considerable area of bone is involved, there may be an indifferent depression, which is probably caused by the absorption of material from the infected area.

If a small, stiff, sharp, steel probe is passed into a sinus it will usually pass into a cavity within the bone, and the end of the root of the tooth will be felt within this cavity. The probe may be passed up and down and partly around the root to determine the extent to which it has been denuded. If the end of the probe is pressed against the softened bone, it will easily penetrate it. The feeling is about the same as if the probe were pressed into a piece of unvulcanized rubber.

A radiograph will show the extent of the region affected. One will occasionally be surprised to find by the radiograph that the condition has involved much more bone than was expected. Gilmer reported a case in which a man nearly seventy years of age had a small sinus over an upper left lateral incisor, and in operating on the case, it was found that most of the maxillary bone on that side had been destroyed by this disease. The floor of the maxillary sinus had been destroyed and it was necessary to remove all of the teeth from the central incisor to the third molar.

TREATMENT. The treatment is surgical, and it should be radical. The area should be opened freely, and every particle of the softened bone removed. This removal is accomplished usually and for the most part by spoon-shaped curettes. The cavity should be irrigated to remove the debris.

Generally when all of the softened bone is removed, the case makes a good recovery. In connection with the removal of the softened bone, it is necessary to either cut off the end of the root which projects into the cavity, or extract the tooth. If the end of the root is to be cut off, the root canal should be filled first. In the more extensive cases, in which the roots of a number of teeth are involved, extraction is preferred to root resection.

Acute Periapical (Alveolar) Abscess

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ILLUSTRATIONS: FIGURES 1761-1772.

IN THIS book, the term periapical has been applied to all of the changes occurring about the apex of the root as sequellae to the death of the pulp. It seems to be preferable, as applied to both the chronic and acute abscess, to definitely distinguish these from the lateral pericemental abscesses which occur in the depths of pockets in chronic suppurative pericementitis. However, it is realized that the term alveolar abscess will be preferred by many, because it has been so generally used to indicate this condition.

ETIOLOGY. As a sequel to the destruction of the pulp from any cause whatsoever, the peridental membrane and bone about the apex of the root may become involved in inflammation. The causes are the same as those mentioned for chronic periapical infections on page 362.

PATHOLOGICAL CHANGES. APICAL PERICEMENTITIS AND PUS FORMATION. The first involvement of the periapical tissues is an apical pericementitis; when such an inflammation progresses to the stage of pus formation, it becomes an abscess. Most cases progress rapidly to pus formation, although occasional cases present in which the periapical inflammation continues for an indefinite period without suppuration. As previously stated, a chronic periapical abscess may be present for years and a change in the virulence of organisms, in the tissue resistance or in the oxygen tension following the opening of the root canal may be conducive to the change to an acute condition; or the chronic abscess may follow the subsidence of the acute, and usually does unless the cause of the acute abscess is promptly removed.

RESORPTION OF BONE. A portion of the bone forming the walls of the alveolus of the tooth is involved by the inflammatory process, and resorption of the bone quickly occurs. The fibers of the peridental membrane of the region elongate as this resorption takes place, extending out to and perhaps maintaining some connection with the bone which is being resorbed, producing a fan-like projection of comparatively large fleshy fibers extending out from the apical end of the root to the resorbed region. Between and among these fibers is the accumulation of pus, rather than in distinct abscessed cavities. As the suppuration proceeds, more of the bone is involved and a definite abscess cavity may be formed.

PUS PENETRATES BONE. The pus soon penetrates the dense plate of bone forming the socket and enters the cancellous bone.

Such bone is easily penetrated on account of the many open spaces. After a few hours more time, the pus will find a way to the surface of the bone, usually nearest the point of the apex of the root, through some Haversian canal which offers an easier exit than another similar canal in the neighborhood, and this is enlarged by resorption, affording an exit of the pus to the surface of the bone, under the periosteum.

In Figure 1761 an acute abscess from an upper central incisor has penetrated the labial plate of bone and the periosteum and is "pointing" on the gum. In Figure 1762 the pus has failed to penetrate the periosteum, but has lifted it away from the bone. This is a subperiosteal abscess. In Figure 1763 an abscess from an upper incisor has penetrated the bone of the palate and has formed a subperiosteal abscess in that position. In the case of the molar teeth, the discharge may be either to the buccal or lingual, or both. In Figure 1764 there is an acute abscess at the apex of the buccal root and pus has penetrated the buccal plate of bone, but not the periosteum, while there is a chronic abscess from the lingual root discharging through the palate. Figure 1765 illustrates the penetration of both the labial plate of bone and the periosteum by an acute abscess from a lower incisor, while in Figure 1766 a subperiosteal abscess has formed because of the failure of the pus to penetrate the periosteum.

The extent of the region of resorption of bone varies, and may occur rapidly in some cases, and slowly in others. All of the changes thus far described may occur over night, and the face may be swollen in the morning, while in others a week may elapse before the bone is penetrated.

IF PUS PENETRATES PERIOSTEUM. When the pus has forced an exit through the bone and periosteum and enters the softer tissues, it will usually form a rounded tumor, occupying the center of a region of infiltration formed to wall it off. Generally within from one to three or four days, if the tissues are not incised, the pus will find an exit through the soft tissues and be discharged. See Figures 1761 and 1765.

IF PUS LIFTS PERIOSTEUM FROM BONE. In a minority of cases, the pus, on arriving at the surface of the bone, meets with sufficient resistance that the periosteum is raised from the bone, and, instead of penetrating the periosteum, the pus spreads out in a broad, flat tumor between the bone and the periosteum, as distinguished from the rounded tumor previously described. This is a subperiosteal abscess, and has been noted in the description of Figures 1762, 1763, 1764 and 1766.

This flat form of tumor over the affected region in periapical abscess is very much the more dangerous form, for it is liable to

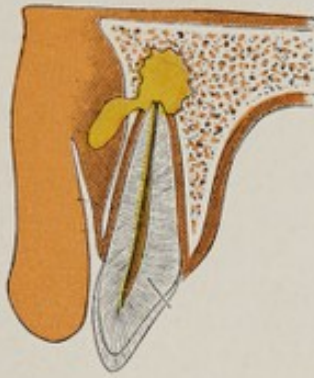


FIG. 1761.



FIG. 1762.



FIG. 1763.

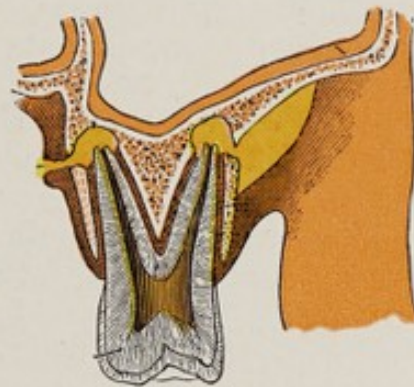


FIG. 1764.



FIG. 1765.



FIG. 1766.

FIGS. 1761 to 1766. Acute periapical abscesses. Various routes by which pus may be discharged. Subperiosteal abscesses.

involve the bone in necrosis. Necrosis occurring from periapical abscess has practically always been in the cases in which the periosteum was lifted from the bone and this broad, flat swelling occurred. Occasionally, the periosteum will build a plate of new bone in its new position. This is called an *involucrum*. It may enclose the necrosed portion. Figure 1775 is of a boy who suffered from a necrosis of the lower jaw on the left side and a large involucrum was so formed. His cheek, which is apparently much swollen, is of the contour shown in the illustration, because of the building of the new subperiosteal bone in that position.

VARIATIONS IN BURROWING OF PUS. These cases, when left to themselves, may present very peculiar features. Pus may find its way beneath certain fascia and burrow to considerable distances. In the upper jaw it may raise the periosteum along the prominences of the malar process, or the malar bone itself, and discharge upon the face. See Figure 1727. Or it may take other directions and discharge upon the face. Or again it may discharge on the gum similarly to the more ordinary form of periapical abscess, or it may raise the periosteum of the alveolar process and discharge between the gingiva and the tooth. In fact, in this class of periapical abscess, the location of the discharge is variable, while in that class which gives the ball-like form of tumor, the location of the discharge is almost universally upon the gum in the immediate neighborhood of the tooth.

DISTINCTIONS BETWEEN PERIAPICAL ABSCESES AND ABSCESES OCCURRING ELSEWHERE.

Periapical abscesses have characteristics by which they are distinguished from all other abscesses occurring within the body. This type of abscess has to do especially with the bones of the jaws and is formed at the ends of the roots of the teeth in the depths of the bony tissue. It is the bone which seems to suffer most, as is shown by the pus cavity forming within the bone. The peridental membrane, which is the real seat of the primary infection, is usually only slightly involved in the formation of the abscess cavity.

INFECTION FROM PULP CHAMBER OF A TOOTH. The first and most important distinguishing feature is the fact that the infection which causes this abscess is derived from the pulp chamber of a tooth after the pulp has died. This infection will continue so long as the infected material remains in the root canal. It is for this reason that the abscess, after the acute stage has passed, takes on a chronic character. Practically all acute abscesses become chronic if not treated, because of this continual reinfection from the contents of the pulp chamber. This is a character found in periapical abscesses, which occurs in no other part of the body and requires special technical treatment. The tooth affected must have proper preparation of the root canal and be completely and perfectly

closed by a filling which is placed in it for this purpose, before the abscess can get well.

CEMENTUM, IF DENUDED, MAINTAINS CHRONICITY. In some of the cases, necrosis of bone occurs in connection with the formation of the abscess, the same as necrosis of bone occurs in other regions in the body, resulting from abscesses in connection with or in the bone. Sometimes fibers of the peridental membrane, covering the root end or some portion upon the side of the root, may be destroyed during the acute inflammation, in which case the vitality of that portion of the cementum is lost and the cementum becomes infected. This cementum then serves to maintain a chronic abscess, for the reason that it can not be exfoliated.

These two items of difference between periapical abscess and other abscesses of the body render it a special form of abscess, presenting interferences to the healing process which require special consideration in treatment.

SYMPTOMS.

The general rule is that acute periapical infections are short and decisive, presenting characters of rapidly growing intensity, running their course to suppuration within a few hours. The progress from the condition exhibiting no symptoms whatever to a definite acute abscess may be so rapid that the intermediate state of apical pericementitis will not be recognized; or the inflammation may be of such a low grade from the first that a chronic alveolar abscess will be formed and exist for a considerable time—possibly for years—without symptoms which will have in any way attracted the attention of the patient.

CONSTITUTIONAL SYMPTOMS. The constitutional symptoms usually consist of a sudden rise of temperature, often ranging from 102° to 105°, with a correspondingly rapid pulse. There may be a preceding chill. The patient may complain of headache, malaise and other symptoms commonly accompanying an acute infection. A blood count will show a leucocytosis.

LOCAL SYMPTOMS. The local symptoms of acute alveolar abscess are: (1) More or less soreness of the tooth; (2) a slight protrusion of the tooth from the alveolus; (3) tenderness of the tooth to use in mastication, or to the touch of the teeth of the opposite jaw, or to percussion; (4) sometimes looseness of the tooth; (5) pain, which may be very persistent and of a dull character, or which may increase very rapidly in severity; (6) there may be a general slight swelling and redness, affecting more or less of the gum tissue, especially on the labial or buccal side, where the tissues are thinnest; (7) an accumulation of pus indicated by fluctuation.

PAIN AND SWELLING. When pus formation occurs rapidly,

there is an increasing soreness which leads to a throbbing character of the pain. The peridental space is so slight that, as the inflammatory reaction becomes more marked, the pain becomes intense, being increased by every pulse beat. Fever will develop at this stage and the temperature will rise as the inflammation increases. The pain may become almost unbearable.

When the pus has forced an exit through the periosteum to the soft tissues covering it, the pressure within the bone is relieved, and almost immediately the intensity of the pain diminishes and more or less swelling occurs, with marked cellulitis in the region, so that patients often report that the pain ceased when the face swelled, and yet that is not quite true. It is a fact, however, that the pain is usually greatly moderated just at this juncture. In a few cases the swelling at this time will be very great. If the case be in the upper jaw, it is not very unusual for the eye of that side to be closed, and the patient unable to open it because of the swelling of the lids and of the soft areolar tissue about it. In some of the severer cases, the swelling may involve almost all the tissues of the side of the face. If the abscess occurs in the lower jaw, the swelling will involve the floor of the mouth and the tissues of the cheek and of the angle of the neck, rather more than the tissues of the face, and present a greater tendency for the pus to be discharged upon the face or neck. It is usually during this swelling of the soft tissues that the temperature is highest. Cases, however, vary from this to the milder forms which present little or no swelling, and little or no pain. Between these two, any variety of rapidity of progress of inflammatory movement, and of fever or lack of fever, may occur, possibly continuing for several weeks.

Ball-like tumor. When the pus escapes from the bone and passes through the periosteum into the connective tissues, an examination with the finger will discover a ball-like tumor, within which fluctuation may be made out. This tumor is inclined, in the great majority of the cases, to point on the gum somewhere in the neighborhood of the nearest approach to the root of the tooth involved, and will, if left to itself, make an opening upon the surface of the gum tissue and discharge its pus into the mouth. See Figures 1761 and 1765.

Flat tumor. In cases in which the periosteum is not penetrated, but is stripped from the bone and the pus accumulates between it and the bone, the tumor is broad and flat. It is more difficult to detect the presence of pus by palpation, on account of the tenseness of the periosteum. Failure of proper diagnosis at this stage inclines to the postponement of surgical interference, and necrosis of the involved bone frequently results. See Figures 1762, 1763, 1764 and 1766.

Painful symptoms subside with discharge of pus. As soon as the pus has been discharged from either of these forms of abscesses, the painful symptoms subside rather promptly. A lingering soreness continues for some days, the swelling disappears and the patient becomes comparatively free from subjective symptoms, but the abscess does not get well. The pus becomes less and less until only a small amount is discharged. The tooth may be used in mastication while there is still a discharge of pus from the opening on the gum, or from the tissues wherever an opening has become established. This is the change from the acute to the chronic form of abscess.

DIFFERENTIAL DIAGNOSIS BETWEEN ACUTE PERIAPICAL ABSCESS AND CERTAIN OTHER CONDITIONS. While there is usually little difficulty in making a positive diagnosis in cases of acute periapical abscess, there are several conditions which may present symptoms which will require a differential diagnosis. The most important of these are fractures of the jaws with swelling, benign giant celled tumor and gumma, also aneurism, cysts, and glandular enlargements. It is not within the scope of this book to go into detail in the differential diagnosis of these conditions, but to call attention to the symptoms, as published in Volume I in the chapter on Oral Diagnosis.

Treatment of Acute Periapical Abscess

It must be held distinctly in mind that the condition which produces periapical abscess is the death of the pulp of the tooth. The infection which occurs in the destruction of the pulp passes through the apical foramen, infecting the tissues in the apical space. In some cases this inflammation may be slight, but in most cases it passes quickly into pus formation.

Usually the organisms enter the pulp tissue through a cavity of decay in the tooth which has exposed the pulp, although they doubtless reach the pulp in a limited number of cases through the blood stream. Thus there may be pus formation in the apical space after the death of the pulp in a tooth in which there is no cavity.

SECURE GOOD DRAINAGE. Most cases of acute alveolar abscess present with a sore tooth, the soreness having developed very recently, with the pain becoming more severe from hour to hour. The first treatment should be to obtain drainage for the pus and relieve the pain. The conditions in the particular case will indicate the plan of treatment to be followed. There are two routes by which the abscess cavity may be reached: (1) through the root canal, particularly during the stage of apical pericementitis, and

(2) through the gum and alveolar process, or in some cases externally on the face or neck.

THROUGH PULP CHAMBER. If the tooth is not too tender to pressure, and if the case has not progressed to the formation of a tumor containing pus, an attempt may be made to open the pulp chamber sufficiently and clean it and the root canals. Sometimes fairly thorough mechanical cleaning of the root canals, especially if the canals are large enough to permit a broach to be passed through the apical foramen, will give relief, by thus giving drainage through the canals. When this is done the rubber dam should be in place, and, after the canals have been cleansed, a dressing should be securely sealed, as has been described in the technic of treating cases of dead pulps. Preparatory to the use of the drill in opening the pulp chamber, the pain which would be caused by the pressure of the drill may be avoided or at least considerably lessened, if a ligature is tied securely about the tooth and traction is made in the occlusal direction while the drill is used. The tooth may be given rest by building up the occlusal surfaces of other teeth with cement. The black copper cement is preferred for this purpose, because it adheres better. A thin layer should be applied on the occlusal surfaces of the bicuspid and molars of both sides of one arch, except of course in the position of the tender tooth. Cold applications should be applied to the face, and a saline cathartic should be ordered; also a hot foot bath before retiring at night.

THROUGH INVESTING TISSUES. The other plan, which should be more generally followed, is to make an incision through the gum for the discharge of the pus, leaving the treatment of the pulp chamber and root canals until immediately after the acute symptoms have subsided. In those cases in which a fluctuating tumor may be palpated, whether the pus be under the periosteum or outside of it, an incision is positively indicated as a first procedure, regardless of the condition of soreness of the tooth.

In those cases which present previous to the formation of a palpable tumor, but with the tooth too sore to justify an attempt at treatment through the pulp chamber, and also in cases in which treatment through the pulp chamber has been tried without securing reasonably prompt relief, one of the very best expedients is to make a considerable cut through the gum tissue to the bone as near the apical end of the root as is practicable. After making this cut, the periosteum should be lifted from the bone for a little distance in each direction by blunt dissection, in order that the pus may more easily make its exit. In addition, an opening may be made through the bone to the region of the apex of the root. This may be done with a sharp bibeveled drill in the engine. This procedure may be employed in only a limited number of cases when the access is good. The severe pain will be relieved in a very short time. Care should be taken not to cut away the periodontal membrane from any part of the root, as this might produce conditions which would render the abscess incurable.

There should be no hesitancy in enlarging openings in the bone, if sufficient care is taken to avoid injury to the peridental membranes. There is no tissue which heals more readily than does bone, and cutting the opening larger seems to make but little difference in the healing process.

The incision through the gum should usually be from three-fourths to one inch or more in length. Otherwise good drainage is not secured, and a second incision may be necessary. The direction of the incision should depend upon the conditions in the particular case; one should be guided by the location of the tooth, the position of greatest tenderness and various anatomical considerations.

Advantages of early incision. Several advantages will often be gained by such an incision. The hemorrhage will relieve the congestion and, if a slight amount of pus should have penetrated the bone to the periosteum, relief will be secured. If the pus has not yet reached the outer plate of bone, it will likely do so within a few hours, and the duration of the pain will thus be cut short. The possibility that the periosteum will be lifted from the bone will be avoided and necrosis will often be prevented. There seems therefore to be every reason for an early incision to and through the periosteum. It would be much better if earlier incision were made in practically all cases. Even though such an incision should be occasionally made when not absolutely necessary, no harm would be done.

If a broad, flat tumor under periosteum. When there is a broad, flat fluctuating tumor which is formed by the lifting of the periosteum by the pus, a very broad incision should be made. It is from this class of cases that necrosis of bone as a sequela of alveolar abscess practically always occurs and the drainage afforded should be such that the pressure will unquestionably be relieved so that the periosteum may drop back to its proper place. See Figures 1762, 1763, 1764 and 1766.

Anesthesia for incision. The administration of nitrous oxid is the best means of securing anesthesia. The incision and cutting of the bone are both very painful, although of but a moment's duration. The use of novocain locally in these cases is generally not satisfactory.

DELAY EXTRACTION OF THE TOOTH. There is a definite danger in the early extraction of teeth with acute alveolar abscess. In those cases in which it is evident that the tooth must be lost, and the patient is first examined after there are indications of abscess formation, the rule should be not to extract until after pus has been discharged by establishing adequate drainage. The injury to the tissues as a result of the extraction gives opportunity for an extension of the infection which may result in a general septicemia, possibly with fatal results. Therefore, the first consideration in these cases is to secure good drainage at the earliest possible time.

IRRIGATION. Following the incision, the wound should be irrigated with salt solution, using for this purpose either the large rubber bulb syringe or a fountain syringe. This should be done with a syringe point having a sufficiently large opening to permit of a free flow of the solution without much pressure, in order to secure the most thorough cleansing and at the same time avoid the danger of forcing the infection deeper into the tissues. It is also necessary that the wound be well opened, to give opportunity for the free return flow of the irrigating solution.

During recent years the tendency among surgeons has been to make very free incisions, and omit the irrigation, relying upon packs moistened frequently with boric acid or salt solution to keep the wound patulous. As a general proposition this plan seems to be giving better results, although it applies more especially to hospital rather than ambulatory cases. There is also a greater tendency for incisions within the mouth to close, as compared with those made through the skin.

In no case should the precaution to keep a free opening through the soft tissue be neglected, for in a great many cases such openings heal very promptly. In broad cuts, through which pus escapes freely, the tissues may reunite within a few hours unless a drain or some form of dressing is used. The opening in the soft tissues may be maintained by placing a strip of gauze in the wound. This should not be packed tightly enough to interfere with the drainage. This should be carried to the depth of the cut and should remain twenty-four or forty-eight hours. The gauze need not be carried into the bone cavity.

OPEN PULP CHAMBER AFTER ACUTE SYMPTOMS HAVE SUBSIDED. During the time of severe soreness of the tooth, no effort should be made to open the pulp chamber. The tooth is tender; every touch upon it hurts, and there is no advantage from such interference. The incision through the gum will relieve the patient of pain earlier than any other treatment, and the opening of the tooth and treatment of the root canals should be deferred until the acute symptoms have subsided. Then these operations can be performed without pain.

TREATMENT OF THE MORE SEVERE CASES.

From the above description of the treatment of periapical abscess it would seem to be simple and effective, and this is really true of the larger percentage of cases. But there are cases presenting which are much more difficult of management; cases which seem slow in the formation of pus, so that there are a number of days of excessive pain accompanied with swelling and increasing fever. In many of these a number of teeth in the neighborhood will be tender to pressure and it is sometimes difficult to locate the tooth which is the cause of the abscess. Cases occur in which the swelling of the tissues may be extensive and

may be distressing and even dangerous by its interference with other functions; as for example, those swellings of the floor of the mouth or neck which interfere with deglutition and respiration; and those about the angle of the lower jaw which, together with the spasm of the muscles attached to the ramus, make it impossible for the patient to open the mouth. There seems to be no treatment which will cut short the course of some of these cases.

RELIEF OF PAIN AND GENERAL SYMPTOMS.

HOT FOMENTATIONS. Employment of other means to relieve the pain and general symptoms should be made. The portion of the face involved may be wrapped in a pack wrung out of cold water in the early stages, in the hope of reducing the inflammatory reaction. In the later stages hot applications give greater comfort. A piece of flannel or coarse cloth may be dipped into the hot water and laid on the face. A heavy towel or rubber cloth laid over this will prevent the very rapid cooling of the pack. This should be kept as hot as the patient can bear for fifteen minutes or more, and then omitted for a time, and repeated as often as seems desirable. An enema should be given as often as necessary to keep the bowels free, and the fluid intake should be increased to prevent dehydration.

INFRA RED LIGHT. The infra red light may be used separately or in addition to the hot fomentations. It is much more convenient to apply and will often give considerable relief.

ANODYNES. Aspirin may be given to relieve the pain, when it is not very severe. In some of the cases in which the pain is the principal factor, not including the development of high fever or other systemic conditions of importance, codine or some other form of opiate should be administered to tide the patient over this very distressing stage. When more prompt relief is desired, $\frac{1}{8}$ or $\frac{1}{4}$ gr. of morphine may be given hypodermically.

BURROWING OF PUS. Sometimes it will be found that the pus has been burrowing in this direction or that, the directions being variable, so that no one detailed description would give a correct idea of them. These are to be looked for continually in the treatment of such cases, and if signs of such burrowing should be found, they should at once be investigated, and the incision extended as may be necessary for drainage. A knowledge of the anatomy and of the fact that pus is liable to become entangled in the fascia of muscles, or in the muscular tissue itself, and follow its fibers, is always something of a guide as to the directions the pus may take, but a description that will cover the cases which may present seems impracticable. The finding of these will depend most on the acuteness of the observer.

A case is recalled in which a patient presented with a tremendous swelling of tissues of the floor of the mouth and of the

neck from the left sterno-cleido-mastoid muscle around to the position of the mental foramen on the right side. The tongue was also much swollen. There was discomfort in swallowing, the patient was suffering severely, had a high fever and could not open the mouth more than about three-eighths of an inch at the incisors. No area of fluctuation could be found by palpation, there was nothing in the history of the case to indicate the tooth which was responsible for the abscess, and it was out of the question to make a satisfactory examination of the teeth. Although it was not expected that pus would be obtained, the skin was frozen with a spray of ethyl chlorid and an incision was made at about the center of the swelling. The cut was made through the skin, about one and one-half inches below the lower border of the bone at the position of the left mental foramen, the direction of the blade being such that the point reached the bone near its lower border. The point was then scraped along the bone, in order to certainly cut through the periosteum for an inch or more. The swelling was so great that a little more than all of the blade of an ordinary scalpel was within the tissues. There was considerable hemorrhage, but no pus. The incision was packed to prevent it from closing. Anodynes were given, hot fomentations applied, a saline cathartic was ordered, also a hot foot-bath before retiring.

The next day there was practically no change in the patient's condition, except that the difficulty in swallowing was increased, and the patient was alarmed because there was some slight interference with respiration. No pus could be palpated. The knife was again inserted into the previous opening, but on reaching the bone was directed to the lower border, under it and a short distance upward on the lingual side of the bone. This incision was successful in reaching the pus and possibly half a teaspoonful was discharged. The wound was irrigated and packed and the patient's recovery was rapid.

In this case, as was afterward learned, the abscess was caused by a dead pulp in the lower second molar. The pus had penetrated the bone on the lingual side, below the attachment of the mylohyoid muscle, and had evidently followed along the inner surface of the bone, keeping below the attachment of the muscle, stripping the periosteum from the bone, without penetrating the periosteum. It had not been possible to locate the pus by palpation, as the mouth could not be opened sufficiently to admit a finger between the teeth, and there was so much swelling that nothing could be learned by an external examination; it was only possible to locate the position of the lower border of the bone by noting it on the opposite side. This was an unusual case in the route which the pus followed, and it was only after very extensive searching that it was found. It is probable that had this patient been taken to the hospital and anesthetized, the mouth could have been opened and the pus located and discharged more promptly, but conditions were not favorable for so doing.

Another very unusual case in the discharge of pus is illustrated in Figure 1770. In examining the teeth of a man about thirty years of age, it was noticed that there was a sore on the right side of his nose almost level with the inner canthus of the eye. A little pus was discharging from this sore. The patient stated that the discharge had occurred at intervals for more than a year and all efforts to cure it had failed. In examining the mouth a sinus was discovered above the right cuspid root. In exploring this, a



FIG. 1770. Case of an acute abscess from the upper right cuspid which was discharging near the inner canthus of the eye.

sharp steel probe was passed into the sinus in the mouth and it came in contact with the end of the cuspid root, about which there was a cavity within the bone. Further exploration with a silver probe revealed a sinus which terminated with the opening on the side of the nose. There was some necrosis of the right nasal bone. With the removal of the bone and the extraction of the tooth, the case made a prompt recovery.

The following is a report of an unusual case of alveolar abscess, taken from the case records of Dr. Carl E. Black, of Jacksonville, Illinois:

"G. B., male; age 48; farmer; married; father of two children; circumstances moderate, home surroundings pleasant; hard

worker; no bad habits; general physical condition had always been excellent; family history good. Urine showed a trace of albumen and numerous granular casts.

"The last of January, 1910, a dentist extracted the lower right third molar on account of pain and soreness about the tooth. About March 1, patient began to have soreness beneath the chin and a little later swelling on right side of lower part of face. After several days he consulted a physician and was referred back to the dentist, who told the patient that he could find no cause in the mouth for the swelling and pain. Patient then consulted another dentist, who thought some part of the molar tooth was still in the jaw and was the cause of the trouble. Patient then went to another physician, who gave him a prescription for his throat and applied antiphlogistine locally as a poultice for about two weeks. The

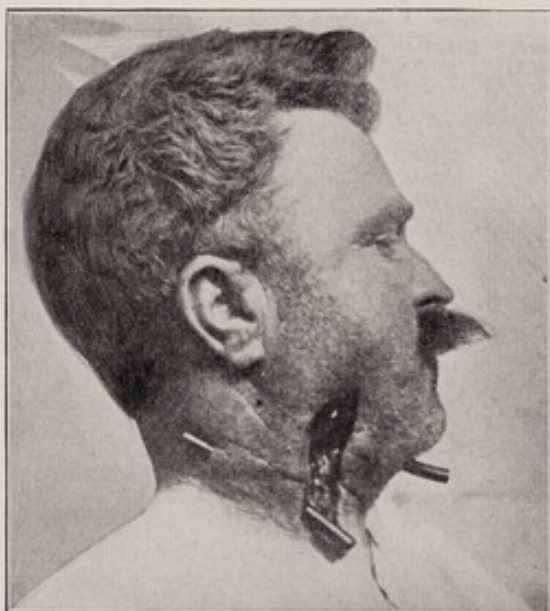


FIG. 1771.

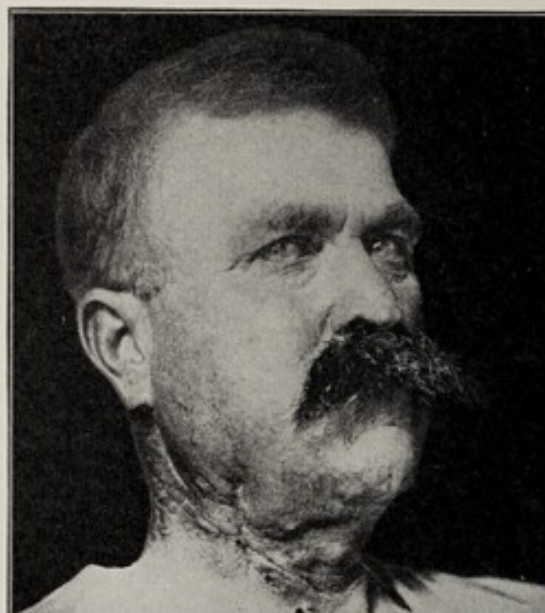


FIG. 1772.

FIGS. 1771, 1772. Case of an acute abscess from a lower third molar. This patient was operated upon by Carl E. Black. See description in the text.

condition grew worse, and the patient consulted another physician who at once decided that the case demanded surgical intervention and sent him to Passavant Hospital and to my care.

"When I first examined the case, March 31, 1910, there was a tense, painful, fluctuating swelling involving the right side of the face and extending from the mastoid process to beyond the median line of the chin and down to the clavicle, from its attachment to the sternum to its middle. There was a constant purulent discharge from the mouth, pouring out from the cavity where the molar tooth had been extracted.

"The patient was given a general anesthetic (ether). After shaving the face and neck an incision was begun at the angle of the jaw and extended to the middle of the clavicle. This exposed

a large abscess cavity below the fascia, or rather a series of abscess cavities connected together by sinuses. A second incision was made below the mastoid and a third in the median line just under the chin. All pockets were opened and broken-down tissue removed and all incisions connected by drainage tubes, as shown in Figure 1771. The main cavity below the angle of the jaw was packed wide open with gauze. One cavity was below the sterno-clido-mastoid muscle. No attempt was made to close any part of the incision. The discharge through the mouth at once ceased and the wounds healed rapidly. Patient left the hospital on April 23, practically well, but with an ugly scar on the face as shown in Figure 1772.

"I did not see this patient again until October 5, 1910. Examination at this time showed that the pain in the right arm at the time of the acute process was not simply a referred pain but that as sequela of the infection he had had a brachial neuritis resulting in permanently diminished sensation in the palmar surfaces of the fingers of the right hand. The muscles between the thumb and the first metacarpal and between the metacarpals of the little and ring fingers of the right hand were much atrophied, and the power of the hand diminished fully one-half for purposes of manual labor."

As one reads the report of this case, as of many others of the more severe cases, it seems evident that a more painstaking and thorough examination leading to a proper early diagnosis would indicate the treatment necessary to cut them short.

Necrosis of the Jaws

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ILLUSTRATIONS: FIGURES 1773-1775.

NECROSIS of bone is defined as death of bone *en masse*. This occurs under widely different conditions, and in any part of the body in which there is bony tissue. An inflammation involving the structure of the bone is termed an *osteitis*; when it involves the periosteum it is a *periostitis*. An inflammation may begin within the bone, as in the case of an *osteomyelitis* in a long bone, or as periapical abscess in the maxillary bones, and extend to the periosteum later. During this inflammation an exudate is thrown out which becomes coagulated, and renders the central portion of the swelling harder than the surrounding tissues, which are swollen.

In the harder central portion of this area, there is stasis of the circulation; that is, the blood does not circulate in this particular portion of the inflamed area. Whenever this stasis is widespread, and long continued, and especially when it involves bone, there is likely to be death of the part of bone that is involved, because of the lack of aërated blood. It can not be thrown off immediately, like the sloughing of parts under severe inflammation and stasis in soft tissue, but remains attached to the living bone for a time. Such amelioration of conditions or of the inflammatory processes must occur as will permit the activity of the healthy bone immediately in conjunction with that which is dead. When this has occurred, a process of resorption is set up in the healthy bone close around the dead portion, by which it is finally separated. The time required for the separation of the dead bone may vary from two or three weeks to as many months, depending upon the conditions in the particular case. The dead piece thus exfoliated is called a sequestrum. See Figures 1773 and 1774. Then the dead portion of the bone may be removed, sometimes in pieces, and sometimes complete in a single mass. After the complete removal of this dead portion, there is usually no hindrance to the healing process.

In most cases there is fairly complete restoration of the bone removed. In a case in which teeth are lost with the alveolar process, the alveolar process, as such, is never reformed, and often this makes quite a deformity in the mouth where large pieces of bone and teeth are lost from necrosis.

Necrosis occurs with considerably greater frequency in the mandible than in the maxillae.

ETIOLOGY.

Necrosis of the maxillary bones frequently occurs as a sequel to the death of a pulp and the formation of an acute periapical abscess; in fact, this is by far the most frequent cause. See Figure 1773. It also occurs as a result of injury, such as automobile accidents, fist-blows, falls, kicks of animals, etc., in which the bone may be fractured. Formerly in regions in which persons were employed in the handling of phosphorus, as in match factories, there were many cases of necrosis of the maxillary bones, due to this poison. Most such factories now engage the services of dentists to care for the mouths of their employees, and have thus reduced the number of cases to a very few.



FIG. 1773. Necrosis. A lower first molar and a large sequestrum removed by Thomas L. Gilmer. The exposure of the pulp chamber may be seen in the right-hand illustration.

Syphilis should also be mentioned as a cause of necrosis of the maxillary bones. The palatal portions of the maxillary bones and the palate bones are almost as frequently involved in syphilitic necrosis as are the nasal bones; in fact, most cases of necrosis occurring in the palate are syphilitic. In persons having syphilis, necrosis is more apt to occur in connection with periapical abscess than in nonsyphilitic persons.

SYMPTOMS.

The symptoms of necrosis may be those of an acute periapical abscess, plus the finding of necrosed bone. Therefore, severe pain and swelling, with high fever and rapid pulse, frequently mark the acute stage. In the more typical cases of necrosis of the maxillary bones, symptoms usually appear which distinguish the case as one of necrosis, without an examination of the bone. The discharge of pus is persistent, it frequently exudes about the necks of teeth in the area of bone involved. The pus is of a thick creamy con-

sistency, and has a very foul odor, which is, of itself, almost sufficient for a diagnosis. The teeth in the region may become very loose and often fall out, or may be removed with the fingers.

If a sharp, stiff, steel probe be passed into a sinus or other opening to the bone which is necrosed, the bone will be found to be hard and rough, often being honeycombed. The examination with this probe alone is sufficient to easily make a differential diagnosis between necrosis and chronic osteitis.

In the rise and progress of necrosis, there is much pain and swelling, as the general rule; yet cases occur in which the pain and swelling are slight. Inflammations involving bone are generally more painful than inflammations involving soft tissue. After the death of the bone and the beginning of the subsidence of the inflam-



FIG. 1774. Necrosis. Two views of a large sequestrum from the lower jaw, removed by Thomas L. Gilmer.

matory process, there is not much pain, providing good drainage is maintained. In all of these cases there is more or less inflammation of the bone until its final removal. A large sequestrum is shown in Figure 1774.

In those cases in which the periosteum is held away from the bone for a time, the osteoblasts may build a layer of new bone in the new position of the periosteum. This bone is called an involucrum. It usually forms a thin shell, which will give a little on pressure. This serves to partially enclose the dead bone and it may be necessary in the treatment to break away some of this newly formed bone. See Figure 1775. This addition of subperi-

osteal bone frequently occurs elsewhere in connection with disease of the bone, or where an abscess exists because of the bridging over and enclosing of pieces of necrosed bone. It not infrequently happens that the bones of the leg are very much enlarged by building on of subperiosteal bone over the region involved, thus strengthening the bone. When a portion of the lower jaw is cut away by disease, leaving the remaining portion rather weak, a plate of bone may be built out in the floor of the mouth reaching, possibly, almost to the center, impeding the movements of the tongue. After the diseased bone has been separated and later replaced with new bone, this plate of bone which had grown out to strengthen the weakened part is removed by resorption. Generally these buildings of subperiosteal bone, which seem to be called out for the purpose of strengthening the weak places, will be resorbed after a time.



FIG. 1775. A boy who had had an acute alveolar abscess from a lower first molar which resulted in an extensive necrosis. After the dead bone was separated, a piece nearly two inches long remained within the tissues for a number of months, pus discharging through a sinus on the neck below the lower border of the bone. The periosteum, which had been lifted from the outer plate of the bone by the abscess, formed an involucrum, part of which had to be cut away in removing the sequestrum. This picture was taken before the operation. The apparent swelling of the left side of the face is due to the new bone, which held the soft tissues in this position. There was really very little inflammation of the overlying tissues at this time. Patient of the author.

TREATMENT OF NECROSIS.

The treatment of necrosis should be: First, the establishment and maintenance of good drainage; second, nonsurgical interference, so far as the bone is concerned, until the necrosed bone has been separated from the healthy bone; third, the care of the patient's general health in the matter of diet, exercise, fresh air, etc.

The loosening of the sequestrum is a physiological process and can be carried on only by the tissue activities in the neighborhood. This not only requires normal activity of the tissues, but also requires time, and this will be long or short, as the tissues are more or less active. Local medication can not hurry it, and

will be much more likely to hinder it. It would be wrong practice to make any attempt to remove dead bone before it had been separated, because it is impossible to tell where the line of demarcation will be established, and to cut beyond into the healthy bone exposes it to the products of suppuration and decomposition, which are always present wherever there is necrosed bone. Such an operation may result not only in the loss of more bone by necrosis, but exposes the patient to the danger of a general septicemia.

SECURE GOOD DRAINAGE. The most essential thing in the treatment of necrosis is the establishment and maintenance of good drainage. Incisions should be made either inside the mouth or outside, or both, to give very free drainage. It is usually necessary to maintain drainage for a number of weeks, and some form of drainage tube or packing may be required for this purpose. Fenestrated rubber tubing may be used in the more extensive cases, or packing of gutta-percha tissue or gauze in the majority.

CLEANLINESS. What has already been said regarding irrigation for alveolar abscess applies to cases of necrosis. The discharge must be unobstructed and the wound should be kept as clean as may be done. Nothing is of greater importance to the early separation of the dead bone, and to the patient's general physical condition, than the maintenance of cleanliness. This treatment will reduce the fever and the swelling and thus keep the patient reasonably comfortable. Cleanliness should be maintained until the necrosed portion of the bone has loosened sufficiently to be removed. Sometimes this will be a very tedious process, requiring several weeks.

EXTRACT LOOSE TEETH. Whenever teeth in the area are very loose and pus is discharging about their necks, they should be extracted. During the period of irrigation, frequent examinations should be made to find pieces of bone which may have separated and each piece should be promptly removed. Oftentimes the necrosed bone will come away in a number of pieces at different times, and each piece removed reduces the inflammation and the discharge of pus. A sequestrum will often be loose, without being freely movable. A stiff, sharp instrument, such as a chisel, may be held firmly against the necrosed bone, and its mobility tested. If it has only very slight motion, so that its removal might be difficult, a few more days may be allowed, when it will usually be found to have more motion.

CATHARTICS AND ANODYNES. During the acute stage, the same general treatment may be employed as in cases of acute periapical abscess. Saline cathartics should be given, a hot foot-bath before retiring, and anodynes if necessary.

Cases of necrosis, in which the patient's general physical condition is much reduced, are best cared for in the hospital, although the majority of jaw cases do not require hospital service. How-

ever, the general health should be looked after in all cases, and it is sometimes desirable to call a physician in consultation for the purpose. A soft diet, moderate exercise and plenty of fresh air should be prescribed.

REMOVAL OF SEQUESTRA. In the removal of large sequestra, it may be necessary to either enlarge the opening through the soft tissues, or to break the dead bone into several small pieces to facilitate its removal. In cases in which an involucrum has formed, which serves to partially enclose the dead bone, it may be necessary to break away at least a part of the newly formed bone, both to make the removal of the sequestrum easier, and to permit the soft tissues to close in and thus advance the healing of the wound. If this shell of bone is left as formed, it serves to maintain a cavity in the tissues for a time.

With the removal of the last piece of necrosed bone, the case will generally heal rapidly. A very small piece of dead bone may, in some instances, be sufficient to keep up a suppuration out of all proportion to the extent of the dead tissue. The treatment after the removal of the sequestrum will depend much upon the conditions in the case. It is generally best, if the sequestrum has been large, and particularly if the cavity is very deep, to place a gauze dressing every other day for a week or two, in order that the cavity may heal from its deepest part. The necessity for removing every piece of necrosed bone, no matter how small, is emphasized by the following case.

A patient had a discharging sinus below the body of the bone of the lower jaw. It was stated that this had been suppurating for eight years, and that several physicians and surgeons had endeavored to cure it by widening the opening in the jaw and curetting. It was noticed that the first lower molar on that side was missing. The patient stated that after some years of trouble, a dentist had removed the tooth, saying that the abscess would get well, but it did not. The full space of the first molar still remained between the second bicuspid and second molar. This suggested the possibility that there might be some infection in the first molar socket. This was before the days of the radiograph.

A silver probe was passed into the sinus, and it met an obstruction at about the position of the mandibular canal. By bending the end of the probe a little, it was possible to pass it farther into an opening under the position of the first molar, which had been removed.

A crucial incision was made in the gum and all of the central portion of it was laid back with a blunt instrument. The bone was completely healed over the socket, but it was only necessary to cut a little away until a cavity was found, and in it a spiculum of necrosed bone, which formerly was the septum between the roots of the first molar that had been removed. The failure to look for this and remove it after the tooth was extracted, had

caused the continuance of the sinus upon the face for so many years. The discharge of pus from this abscess ceased within four days, the tissues healed and the case remained well.

One of the worst cases of necrosis of the maxillary bones which have come to the author's attention was that of a man about thirty-five who had for years been in the habit of trimming his fingernails with his incisor teeth. He could start at one side and by a series of bites trim an even piece off the end of a nail, almost as smoothly as this could be done with a pair of scissors. One day he called on his dentist, Dr. W. B. Young, of Jacksonville, Ill., complaining that his upper incisor teeth were loose. On examination, Dr. Young found these teeth very loose, and the alveolar process necrosed; pus was being discharged about all four incisors. There was also swelling of the tissues farther back on both sides of the mouth. He extracted the four incisors, and noticed a foreign substance alongside the root of one of the centrals. This proved to be a cutting from a fingernail, which had evidently slipped up under the gingiva as it was bitten off. This apparently was the cause of the infection, which spread rapidly, and eventually involved all of the alveolar portion of both superior maxillary bones. Pus penetrated both antra and was also discharging about the necks of all of the remaining teeth. The author was called to see the case, and found it necessary to remove all of the remaining upper teeth. Several sequestra came away with the teeth, including parts of the floor of both antra. During the next few weeks additional sequestra were removed. The case finally made a good recovery.

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FOCAL INFECTION

EDWARD H. HATTON, B.L., M.D.

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ILLUSTRATIONS: FIGURES 1801-1804.

INTRODUCTION. A focus of infection was defined and explained by Billings as, "a circumscribed area of tissue infected with pathogenic microorganisms. Foci of infection may be primary or secondary. Primary foci are usually located in tissues communicating with a mucous or cutaneous surface. Secondary foci are the direct result of infection from other foci through contiguous tissues or at a distance through the blood stream or lymph channels." As the subject is understood today, focal infection is a low grade chronic process and the causative microorganisms, for the most part, are streptococci and staphylococci. The secondary manifestations may be painful, crippling and very debilitating and the function of the involved parts is generally materially inhibited. As a rule, however, the process does not threaten life, at least in the earlier stages. This type of infection should not be confused with the fulminating focal form due to virulent organisms, causing lesions of the septicemic and pyemic varieties, although, except for the virulence of the associated bacteria, the nature of the process is quite similar. Indeed, in some instances acute focal infectious conditions may produce secondary symptoms quite characteristic of secondary focal infection.

The rapid development of the principle of focal infection in the last two decades may be ascribed to a number of causes. It began as a hypothesis or theory, but with the rapid accumulation of experimental and clinical evidence, it has advanced to a principle that is widely used in the treatment and control of a large group of diseases by practitioners in both medicine and dentistry, as noted by Holman. Some of the reasons for this remarkable change are worthy of comment. In the first place, the outstanding accomplishments of the application of the relatively new science of bacteriology to the problem of acute infectious processes gave birth to a hope that similar results were attainable in the management and control of chronic conditions of an infectious nature. In the second place, the opportunities for research in the study of acute infections were becoming less numerous and less promising. In the dental field the discovery and widespread application of the X-ray was no small factor in the evolution of the focal infection principle, in so far as it concerns lesions in the jaw bones. Finally, the progressive group of dentists, inspired by the achievements of W. D.

Miller, G. V. Black and many others, was especially receptive to a theory that would broaden and emphasize the health conservation phase of dental practice. All of these factors lead to an almost revolutionary change in the point of view and accepted methods, in so far as they had to do with chronic infections about the teeth.

EVOLUTION OF THE FOCAL INFECTION PRINCIPLE.

The starting point of this change is said to be the address of William Hunter, at the opening convocation of the Medical College of McGill University in 1910. The delivery of the Lane lectures at Stanford Medical School in September, 1915, by Frank Billings, may be referred to as the end of the developmental period and the beginning of its widespread application as a working principle in the practice of medicine and dentistry. Billings was the director of

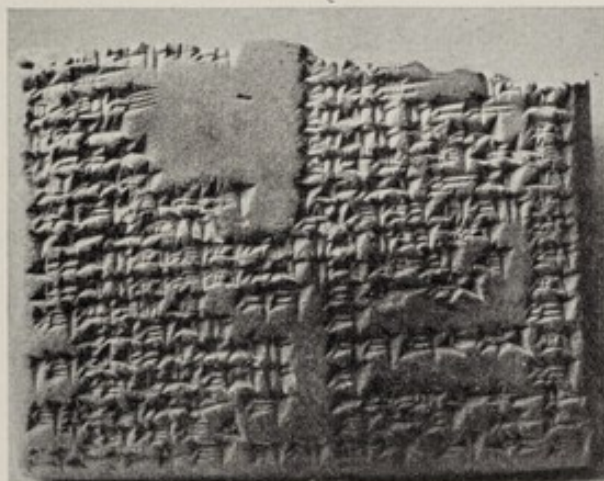


FIG. 1801. Photographic reproduction of the original cuneiform tablet in the British Museum, in which a physician advised his king in ancient Assyria, 2600 years ago, that his teeth must be extracted for relief of the condition from which he suffered. Photograph supplied by the British Museum.

and the spokesman for an active and unusually capable group of investigators who had been studying this problem for the preceding twelve years. He adopted and advocated the use of the terms focal infection and focus of infection* which, since then, have been used quite universally.

However, it must be said that the notion that low grade infections, especially of the mouth and teeth, may cause chronic diseases in remote parts of the body is not at all new and a sole product of this generation of physicians and dentists, even if no other generation has accepted this idea so whole heartedly. The oldest known record of the extraction of teeth for the purpose of curing systemic disease is found in a letter of a court physician, Arad-Nana, to his king, some 2600 years ago. See Figure 1801. The translation of the inscriptions of a cuneiform tablet recovered by excavations at the site of an ancient Assyrian city was made by

*See reference to the use of this term by W. D. Miller in 1891, referred to in a subsequent paragraph.

Professor A. T. Olmsted, of the Oriental Institute of the University of Chicago, as follows:

"Continually the King has been asking why Arad-Nana has not made clear his disease and cured him. Now Arad has sent a sealed letter which he hopes they will read before the King. He will make prescription; let the ceremonies be carried out by a seer; let them bathe the King and straightway the fever will depart from the face of the King; let them apply to him oil two or three times. There is infection in the pus; let them bring licorice before the King, as they have done twice already; let them rub it in vigorously, then he will come and give further instructions. At once the strength of the King will revive, in the midst of the full tide to the King he will bring. The King shall place on his neck the salve Arad will send; on the appointed day let the King be anointed. Arad will speak the truth with the King, as the King demanded; the pain in his sides, and his feet has come from his teeth, and they must be extracted from his face."

This tablet is one of a large number which were discovered in the ruins of Nineveh and Ashur, capitals of Ancient Assyria. The time is between B. C. 648 and B. C. 626. The King referred to is probably the one named Aanapper in Ezra 4:10.

It is a wide gap from this ancient Assyrian to Benjamin Rush, a Philadelphia physician and a signer of the Declaration of Independence. Rush was a man of wide influence both in and outside of his profession and a resourceful as well as an observant clinician; the following quotation from his book might have been written today rather than over one hundred years ago:

"I have been made happy by discovering that I have only added to the observations of other physicians in pointing out a connection between the extraction of decayed and diseased teeth and the cure of general diseases. . . . I cannot help thinking that our success in the treatment of all chronic diseases would be very much promoted by directing our inquiries into the state of the teeth in sick people and by advising their extraction in every case in which they are decayed. It is not necessary that they should be attended with pain in order to produce disease."

Holman, in the article already mentioned, names John Abernethy (1809) as another physician who had the same notion as Rush with respect to diseased teeth. It is quite certain that, in the long interval between Arad-Nana and Benjamin Rush, there were many others who gave attention to diseased teeth in their clinical practice, even though the records are, for the most part, silent.

From about 1800 to 1910, a little more than a century, references to this thought are more common in the writings of physicians and dentists. Arthur D. Black, in an article on the relationship between eye diseases and dental infections, lists articles as early as 1842 bearing on the causal connection between diseased teeth and eye affections. Garretson (1890) ascribes various systemic conditions to dental disease. It is very interesting that W. D. Miller,

in the very next year, used the phrase "focus of infection" with reference to conditions in the mouth. He said, in part, "During the past few years the conviction has grown continually stronger among physicians as well as dentists that the human mouth as a gathering place and incubator of diverse pathogenic germs, performs a significant role in the production of various disorders of the body, and that, if many diseases whose origin is enveloped in mystery could be traced to their source, they would be found to have originated in the oral cavity." He lists these conditions under thirty-eight heads; however, most of them have to do with diseased conditions within the mouth rather than remote from this region. Of those that pertain to other parts of the body, he mentions septicemia, pyemia, meningitis, encephalitis, brain abscess, disturbances of the alimentary tract, diseases of the lung, croupous pneumonia, lymphadenitis, infectious anginae and maxillary sinus disease. Antedating Miller's paper by some seven years is the small book by G. V. Black, having to do with the formation of toxic substances by bacteria and their probable effects in the causation of disease.

For more than ten years prior to 1910, the year of his visit to America, William Hunter had been stressing the danger of oral sepsis and its etiological relationship to such diseases as anemia, endocarditis, nephritis, etc., yet it is generally agreed that it was not until after his address at McGill that much attention was paid to his ideas. There is no doubt but that his denunciations reached the ears of the American dentists at this time. As noted by G. V. Black, "He lashed the dental profession unsparingly for allowing chronic abscesses and other forms of chronic supuration to continue in the mouth. Dr. Hunter called attention to the fact, as it had never been done before, that the foci in the mouth are in the same causal relation to arthritis, nephritis, cholecystitis, endocarditis, etc., as are infected tonsils, or chronic supurations in any other location. Dr. Hunter was especially severe in his denunciation of the habit of placing plates over infected roots, anchoring bridges to abscessed teeth, or teeth with inflamed or suppurating gums, or placing artificial crowns on such roots. Any artificial replacement which promotes uncleanness came in for condemnation."

Several paragraphs from Hunter's paper are reproduced as follows: "The title 'oral sepsis' was first introduced into medical literature in a paper entitled, 'Oral Sepsis as a Cause of Disease.' (British Medical Journal, July, 1900). My object in seeking for a special name, and after consideration in creating this one, was to emphasize the great fact that it is not the absence of teeth but the presence of sepsis; that it is not dental defects, but septic defects; that it is not defective mastication, but the effective sepsis associated with such dental defects, or often present in conditions of gingivitis apart from such defects, that are responsible for the ill-health associated with 'bad' mouths.

"The second object was to emphasize the importance of the infection caused by staphylococcal and streptococcal organisms, as distinguished from the purely saprophytic infections in which the mouth abounds; or the temporary presence of specific organisms; e.g., typhoid, tubercle, pneumonia, etc.

"The subject of 'oral sepsis,' as I designated and defined it, namely, the septic lesions of streptococcal and staphylococcal infection found in the mouth, belongs to no one department of medicine or surgery. It is common ground on which the general doctor, physician or surgeon; the throat, nose, ear and eye specialist; specialists in children's diseases, and lastly, the dental surgeon, all meet on terms of equal responsibility. In its earliest manifestations no special knowledge is required to deal with it; a sound grasp of the principles underlying antisepsis alone is required. Unfortunately for the patient, it is precisely this grasp which I grieve to say is wanting.

"As I originally showed (1900), and my further experience of the last ten years, supported by that of many others, fully demonstrates, the ill effects are both common and grave. That they are not more common is due solely to the great resisting power possessed by the mucosa of the mouth and gums."

It seems quite clear, both by their terminology and by their discussions, that the predecessors of Billings had in mind a sharply localized process limited to the mouth. Both Miller and Hunter use the term "Oral Sepsis" to describe the primary lesion and Rush limited his observations to the effects of the removal of decayed and diseased teeth. Their conclusions were based solely on clinical observation and they inclined to the belief that the secondary conditions were brought about by the absorption of poisons or toxins in small amounts from the local lesions in the mouth. Billings and his group attacked the problem from every point of view and, on the basis of their well correlated clinical and experimental methods, were able to show that infections of other organs and tissues than the teeth may be primary foci and that the process may be embolic as well as toxic. One of the original associates of Billings was Edward C. Rosenow. Of him it has been said, "Fortunately the experimental basis for focal infection is most convincing, due to the brilliant work of Rosenow. Rosenow made a fundamental contribution to bacteriology in demonstrating that the bacteria concerned in chronic foci of infection are very sensitive to oxygen tension, and that the cultivation of the organisms and the reproduction of lesions in animals is largely dependent upon the use of proper laboratory technic. . . . This work furnished the needed experimental basis for the concept of focal infection, since it demonstrated experimentally a causal relation of foci of infection to systemic lesions and provided an explanation for many clinical observations."

Thomas L. Gilmer, because of his close acquaintance with Billings, investigated the relationship of apical infections to sys-

temic diseases. He with A. L. Moody found that the incidence of streptococcus viridans in these chronic alveolar infections was much higher than for any other organism and that these bacteria were distinctly pathogenic.

The studies of Frederick B. Noyes and Kaethe Dewey on the distribution of lymphatic vessels in the tooth pulp and the peridental membrane, as well as the course of the lymphatic circulation out of these parts, have a very important bearing on focal infections transmitted from the teeth. This work has not received adequate recognition by writers and investigators in this field. This would seem to be inexcusable since the results of their investigations were published in both medical and dental journals. A careful comparison of the histological changes in these chronic infections of the peridental membrane and the lymphatic distribution as shown by these authors indicates a high degree of parallelism. The most noteworthy infiltrations are around the lymph spaces, especially those close to the blood vessels. Both bacteria and toxins may gain entrance much more readily into the lymphatics and the lymph spaces in such regions than into the blood vessels, even though the latter may be dilated and deformed with abnormally thin walls. The distribution of both bacteria and toxins to other parts of the body, therefore, may be initiated without thrombosis in the deformed vessels in this region or without any change in the permeability or other physical changes in the nature of the walls of these vessels.

The above is but a very brief statement of the story of the evolution of this fascinating phase of medicine and dentistry. It is not possible within the limits imposed by the nature of this chapter to give adequate credit to the host of investigators and clinicians who have made outstanding contributions, which have to do with the adoption of the focal infection principle as a valuable and fertile asset in the diagnosis, treatment and control of many infectious processes of a chronic character. Neither should undue emphasis be ascribed to those whose names have been listed here or in the bibliography at the end of this chapter.

PATHOLOGIC CHANGES IN FOCI OF INFECTION.

As stated by Billings, "Infection of the teeth and jaws, with especial development of pyorrhea alveolaris and alveolar abscess, infection of the faucial and naso-pharyngeal tonsils and of the mastoid and accessory sinuses, are the most common forms of focal infection." As to the secondary processes, he continues, "Secondary foci may appear in various tissues as a part of the general or local disease which results from a primary focus. As we shall see, systemic and local diseases may occur through infection from a focal point by way of the blood stream. This mode of infection is often embolic in character. The tissues so infected may constitute new foci, which in part explains the chronicity of many local and general infections."

Primary foci are usually located in tissues communicating with a mucous or cutaneous surface. This fact deserves much more elaboration than is given to it conventionally. A smooth, intact surface is highly unfavorable to bacterial penetration and to the formation of thriving colonies of bacteria. This principle is well understood, since the entrance of bacteria into subcutaneous tissues is generally brought about by some break in this surface by actual injury. Acute processes are set up by a single injury, accompanied by the introduction of virulent bacteria into these regions. Favorable conditions for the establishment of local chronic processes are not necessarily the result of single injuries, but from the formation of folds, crypts and pits in the epithelial covering. Repeated low grade injuries of the gingivæ between and around teeth and the resulting gingivitis serve as the starting point for most cases of chronic suppurative pericementitis. Colonies of bacteria develop in the defects produced, especially if the external opening of the defect becomes narrow with the formation of a flask shaped recess in the epithelial covering. In such places the bacteria are protected and colonies are established as a rule, rather than as an exception. The epithelial barrier between the bacterial colony and the adjacent connective tissues undergoes retrograde changes as a result of the irritation of bacterial growth and activity within the recess. Deformation, disappearance of the keratinized layer and uneven growth of the epithelium favor either actual penetration of bacteria into the adjacent connective tissues or diffusion of the products of bacterial growth into the tissue fluids, lymphatics and blood vessels of this region. The capillary loops just beneath the epithelium and between its deformed projections into the subepithelial layers share in these degenerative changes, as in some places the lumen is dilated and in others noticeably constricted.

Although such anatomical conditions prevail in all parts of the body which are the common sites of primary foci, yet in no place is the condition so characteristic as in the tonsil. Although the outer surface of the tonsil may be smooth and without folds and pits in the earlier years, this form does not usually persist. Repeated enlargement and shrinkage associated with frequent inflammations, due to naso-pharyngeal infections, produce wrinkles, deep pits and crypts, many of which have narrow necks and dilated recesses, with abundant and thriving colonies of streptococci and staphylococci. Similar conditions are found in the linings of such organs as the large bowel, the appendix, the prostate, Fallopian tubes, and in deep pyorrhea pockets. The conditions in apical granulomas are atypical, since there may be found little or no epithelium in the form that serves as a primary focus and, as a rule, there is no connecting channel to a mucous surface. In all other respects, periapical infections are like other primary foci.

Figure 1802 is a section of an apical granuloma showing a dilated and deformed capillary in the midst of perivascular infiltrations. Figures 1803 and 1804 are illustrations of the lining membranes of two pyorrhea pockets in which dilated and deformed

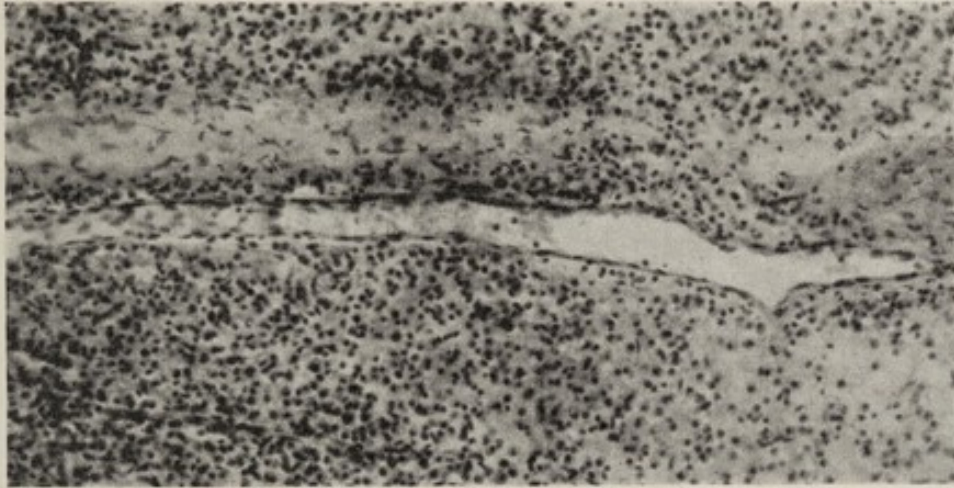


FIG. 1802.



FIG. 1803.



FIG. 1804.

FIG. 1802. Perivascular inflammation in a periapical granuloma.

FIGS. 1803, 1804. Round celled infiltration about dilated capillaries in the tissues involved in chronic pericementitis.

capillaries are also shown among cellular infiltrations. In both cases the lining membrane is to the right. The capillaries are separated in such locations from the pocket only by a very fragile layer of epithelium not more than two or three cells in thickness. Ample opportunity is, therefore, afforded for diffusion of toxic products into the lymph spaces and into the capillary blood in these loops, also the conditions are favorable for the formation of thrombi within the loops. The dissolution of the thrombi may give rise to emboli which may carry bacteria with them, or the bacteria may pass directly into the lymphatics. This is an amplification of the statement made by Billings previously quoted, that, "This mode of infection is often embolic in character." These emboli are prone to lodge in remote parts of the body where the capillaries are small or already have undergone some change. No doubt changes in the viscosity of the blood or in the stickiness of the capillary linings may be as important as irregularities in the diameter of the capil-

lary walls. It would seem that such local conditions are of more importance in determining localization of the secondary lesions than some specific properties of the bacteria themselves.

It seems that there is abundant opportunity for the origin from such oral conditions of both forms of secondary foci, one of which is purely toxic and the other embolic or metastatic. This is borne out by clinical observation. In the first instance, bacteria are not carried to the secondary locations, but only the toxins or the products of the reaction between the bacteria and the tissues. These may be partly digested bacterial proteins or the products of bacterial metabolism in the primary focus. It is a matter of clinical observation that the secondary symptoms in a considerable number of cases disappear promptly after the elimination of the primary focus. Such instances belong to this first group. In the second place, the process is embolic or metastatic and the bacteria are carried to and lodge in the secondary focus, setting up new bacterial colonies. The elimination of the primary focus, in such a case, will not of necessity cause any change in the secondary lesion or lesions. This condition fits clinically with those cases that are not improved materially or only very slowly by the elimination of the primary focus. In such cases, the secondary lesion is in fact a new primary focus.

The process may or may not progress to the stage of pus formation in the primary lesion. In general, suppuration is not common, or at least not extensive, and is limited usually to the crypt or recess in the epithelial covering from which the pus may be discharged through the narrow opening, as in the case of the pyorrhea pocket. Extensive suppuration is characteristic of acute processes, and, although such a complication may arise in a primary focus at times, it is not an essential or characteristic feature of the primary focus.

Acute and semi-acute oral infections may be responsible for secondary manifestations, such as neuritis, myositis, iritis, headache and other forms that are characterized by painful symptoms, often of the referred type.

TYPES OF BACTERIA WHICH CAUSE FOCAL INFECTION. It may be said that foci of infection are caused by relatively few types of bacteria, especially streptococci and staphylococci. Of these the strains and forms that have to do with severe and acute processes are not usually concerned with focal infection. Streptococci of the viridans type, of a relatively low grade of virulence, are considered to be of very great importance. Since these forms of streptococci are very common in the mouth and are frequently associated with both chronic pericementitis and apical infection, the significance of tonsil and dental infections is clear.

LOCATION AND TYPES OF PRIMARY ORAL FOCI. Two sites of oral primary foci, other than the tonsils, have been named, pyorrhea pockets and periapical infections. Both of these favor the localiza-

tion of well protected colonies of bacteria. Either may cause secondary conditions of the toxic or embolic type, although in pyorrhea it would seem that the secondary manifestations are predominantly toxic, whereas in periapical infections the conditions favor actual migration of bacteria from the primary to the secondary focus. Particular attention should be paid to the deep pyorrhea pockets, including those in the bifurcations of molar teeth, as these conform very closely to the flask shaped situation already described, and are highly favorable to the development of localized colonies and the dissemination of infectious processes.

All periapical infections must be considered as potential primary foci. However, cases showing large rarefied areas in the radiograph are less likely to be active foci than the small ones. The large regions are more apt to be filled with a fibrous granuloma, with a minimum amount of inflammatory infiltration, or to be occupied by a cyst which has evolved out of a granuloma. In some instances the localization of the infectious process is limited to the pulp of the tooth, and the periapical region will not be involved for a long time, so that the condition is not disclosed by x-ray examination.

These circumscribed pulp infections are, as a rule, limited to the coronal pulps of molar and bicuspid teeth. Generally, when the pulp has been grossly exposed by caries the infectious process advances fairly rapidly, with early involvement of the periapical region. In cases in which amalgam restorations, inlays or crowns cause first a hyperemia and later an inflammation of a pulp, the eventual death of the pulp may be long delayed, although there may be a well circumscribed primary focus in the coronal portion of the pulp. Such a condition may result from failure to remove all of the infected dentin at the time the cavity was prepared, or a form of pulp degeneration may occur that is peculiarly susceptible to infection of embolic origin. The number of bacteria presumably introduced in either way is relatively small, compared with the massive inoculation that follows pulp exposure by caries. In any case, the process is slowed down in these so-called vital pulp infections and the infected region is partly walled off by fibrous tissue which may become more or less calcified. Symptoms and signs of infection, especially pain, are either lacking or of a very deceiving character, because they are not localized. Pain is a rather common complication of such conditions, but it is more likely to be referred than to be localized in the tooth by the patient. The situation becomes even more confusing if there are adjacent pulpless teeth. The hyperplastic pulp may at times assume the character of a primary focus of infection. These are found most frequently in the mouths of children and relatively young persons. Both of these forms of pulp infection are to be considered as variations of the periapical type of infection.

The infections that occur around the crowns of partly erupted or impacted teeth may be primary foci. In this respect, they act like the pyorrhea type of primary focus and should be classified

with them. The inflammations of the gum tissue about the crowns of partly erupted teeth and the pyorrhea pockets seem to serve as local foci for recurrent attacks of acute ulcerous gingivitis. In this connection, it should be noted that tonsils are even more likely to harbor these organisms.

INCIDENCE AND SIGNIFICANCE OF ORAL PRIMARY FOCI.

The incidence of mouth infections is very high as is demonstrated by the data collected by Arthur D. Black and shown in the accompanying table. In a study of 600 persons in all age groups, 57% of those under 25 years old had rarefactions in the alveolar bone, with an average of two regions per person (apical 1.4 regions; peridental 0.6). Of those over 50 years of age, 98% had rarefactions in the bone, with an average of 10.3 regions per person (apical 1.3 regions; peridental 9.0). Of the 600 persons included in the study, 78% were shown to have rarefactions of the maxillary bones. It is stated that the small number of apical infections in the mouth of elderly persons was probably due to extractions, as this group had an average of 22 teeth, while the younger group had an average of 29.5 teeth. As these have all of the characteristics of either actual or potential foci of infection, granting the validity of the focal infection principle and the possibility of relating such infections to systemic disease, one is impaled upon the horns of a dilemma. Either the significance of these mouth infections as primary foci is to be greatly discounted, especially in individuals who have a considerable amount of oral infection, but are otherwise in good health, or else every mouth infection of the type previously described, and demonstrated in these x-ray examinations, is to be considered as a serious menace to a person's health. In the face of such a situation it is not surprising that two radically different conclusions have been reached in the analysis of the available data. In one instance the conclusion avoids the dilemma by minimizing the part played by mouth infections in initiating secondary lesions, even to the extent of assuming that mouth infection, especially of the periapical type, is secondary rather than primary. Those that accept this point of view argue that if mouth infection were so important and so serious, secondary focal infection would be well nigh universal, which, of course, is very far from being true. Adhering to the second conclusion are those who lay great emphasis on these oral infections as the initial phase of generalized focal infection. They insist, furthermore, that any temporizing with mouth infections is a serious matter even in healthy individuals and that the removal of the teeth is the only safe plan of management.

Such extreme diversity of opinion, of course, could not exist if there were accepted methods for the accurate diagnosis of a primary focus, or if there were fairly accurate data for the incidence of the location of active primary foci. Attempts have been made to devise satisfactory diagnostic methods and to collect reliable data that bear on the incidence of the primary foci as

TABULATION FROM 6,000 ROENTGENOGRAPHIC FILMS OF TEETH AND ADJACENT BONE IN MOUTHS OF 600 ADULTS*

Age	Systemic Symptoms			Periapical Abscess			Summary			Root Fillings			Large Canals			Small Canals			Periapical Abscesses		
	No History	Complaint of occasional muscular or joint	Well defined cases, arthritis, nephritis, etc.	Average number of persons, some bone destroyed at sides of roots	Percentage having bone involved	Average number of infections per person for entire number	Number of persons, some bone destroyed at apices of roots	Percentage having bone involved	Average number of abscesses per person for entire number	Number of persons having periodontal or apical infections or both	Percentage of persons having infections of maxillary bones	Number of persons having root fillings	Number of good root fillings	Number of poor root fillings	Number of good root fillings	Number of poor root fillings	Number of good root fillings	Number of poor root fillings	Number of good root fillings	Number of poor root fillings	Number of good root fillings
20 to 24.....	9	120	11	18	13	0.6	77	52	1.4	89	57	103	357	8.6	72	85	10	120	83	42	71
25 to 29.....	9	90	14	34	29	2.0	60	51	1.3	75	64	83	338	9.8	60	54	8	111	66	41	45
30 to 39.....	146	30	25	101	68	5.7	92	63	1.4	119	88	116	504	13.0	89	94	8	168	93	46	107
40 to 49.....	111	29	13	87	77	7.1	65	59	1.5	100	90	80	329	12.0	74	60	2	117	75	28	7
50 and over..	78	22	9	69	88	9.0	39	50	1.3	77	98	46	167	8.9	32	50	3	54	40	27	2
Totals.....	600	99	72	319	53	5.0	333	55	1.4	469	78	428	1,695	9.8	344	343	31	570	356	184	19

Large Canals: Upper—central incisor, cuspid, second bicuspid, lingual roots of molars; lower—cuspid, first bicuspid, second bicuspid, distal roots of molars.
Small Canals: Upper—lateral incisor, first bicuspid, buccal roots of molars; lower—incisors, mesial roots of molars.

SUMMARY OF ABSCESES IN RELATION TO ROOT FILLINGS

Good root fillings, large canals.....	343	31	50
Good root fillings, small canals.....	184	19	50
Poor root fillings, large canals.....	570	356	271
Poor root fillings, small canals.....	413	271	627
	1,510	677	677

Percentage of abscesses for all root fillings, 45; for good root fillings, 9; for poor root fillings, 63.

The figures given in this tabulation are believed to be very close to average figures for persons under 40; for older persons they would doubtless show a higher percentage of infection than the average.

*Black, Arthur D. Roentgenographic Studies of Tissues Involved in Chronic Mouth Infections. Jnl. Amer. Med. Assn., Vol. 71, 1918, p 1279.

related to specific diseases. The diagnostic problem will be discussed later.

Only in the case of iritis is there available extensive data with reference to the relative location and nature of the primary lesions. The facts tabulated have been developed largely by therapeutic test. On the basis of careful examination, for each case of iritis it has been assumed that some given local infection is responsible. If the iritis is cured by the elimination of that infection, it is concluded that this condition under suspicion is the cause. If the condition is not cured or not very materially improved, other suspected locations are eliminated, one by one, until the disease is brought under control, if possible. Such statistical material may show one or more foci, or the focus which caused the iritis may not be discovered. In all but the first instance, especially in estimating the relative importance of multiple foci, there must be some doubt as to the validity of the conclusion reached. There is no dearth of this sort of statistical material for iritis. Rather recently Gifford has compiled a single table for the results of a number of different investigators. Concerning the tooth factor there seems to be less variation of opinion than with respect to any other, since the maximum figure is 13.5% and the minimum 11.1% for all authors.

ETIOLOGY OF IRITIS.

Primary Lesion	Irons & Brown	Gifford	All Authors
Syphilis	19.0%	16.9%	19.8%
Tuberculosis	4.0%	8.5%	17.2%
Tonsils	26.5%	22.0%	9.3%
Teeth	13.5%	12.7%	11.1%
Other chronic infections.....	.....	.....	17.6%
Combined infections or no cause given.....	24.0%	32.6%	22.7%
Sinuses	2.0%	6.8%	2.3%
Number of cases.....	200	118	1,234

Usually, in the instances where the foci were considered to be multiple, tooth infection was thought to be one of the factors. In no other secondary disease, thought to be caused by focal infection, do syphilis and tuberculosis seem to play so important a part in etiology as in iritis. With their elimination, tooth and tonsil infections rank higher in relation to other secondary foci. On the basis of such data, one may ascribe not more than one-fourth of the secondary foci to a primary location in either of these two regions, with little choice between the teeth and the tonsils.

In the preceding discussion, except for the general significance of mouth infection, there are no matters that have caused serious controversy. As has already been stated, focal infection may be considered as an established principle. The evidence in its favor is partly clinical, consisting of relief from the secondary manifestations of disease, following the elimination of what have been believed to be the primary foci. A second sort of evidence has been obtained by the isolation of bacteria from what have been con-

sidered to be primary lesions in man and the production of lesions in inoculated animals, which are similar in most essential respects to the secondary conditions found in the original host.

Rosenow's criteria for the demonstration of this relationship are somewhat more elaborate than implied in the preceding statement. According to him an organism capable of producing the diseased condition must first be isolated from the suspected primary focus. The same organism must, in the second place, be recovered from the secondary lesion. In the third place, both of these organisms inoculated into experimental, susceptible animals, must produce predominately lesions of the same kind as the secondary manifestations in the patient. Finally the same organism must be recovered from the lesions in the animals. This is an effort to verify this relationship by the application of Koch's postulates. There are several weak links in this argument. The dosages of bacteria used in inoculating the animals are huge, so large that the susceptible animals used are overwhelmed by the massive inoculation with the formation of lesions in practically all organs and tissues in the body. The fact that they locate predominately in one place is far fetched, so far as Koch's postulates are concerned. The identification of the organisms recovered from the primary and the secondary foci does not of itself prove that either is necessarily the original site of invasion. One may be, although the same situation could exist with the site of invasion in a third location.

Joseph L. Miller, in discussing this situation, says: "The presence of microorganisms in a pulpless tooth or apical abscess is not evidence that this infection is responsible for pathologic changes elsewhere in the body. The usual method adopted for determining their pathogenicity for man is animal inoculation. The animal usually selected is the young rabbit. The adult rabbit is fairly resistant to infections; the young, highly susceptible. In all of this experimental work, relatively enormous doses of bouillon cultures are introduced intravenously. In a recent article on the dangers of pulpless teeth, the investigator injected 5 c.c. of a bouillon culture into a 1,500 gm. rabbit. This is the equivalent of 250 c.c., or $\frac{1}{2}$ pint in a man weighing 160 pounds. While this dosage is above the average employed, rarely is less than 1 c.c. used, the equivalent of 50 c.c. or $1\frac{2}{3}$ ounces for man. When positive results are obtained in animals, the deduction is immediately reached that the source of this culture is a menace to its host. They have actually shown that a massive dose of a certain microorganism is capable of producing a pathologic lesion in a susceptible rabbit. The inference in regard to the host is wholly gratuitous."

Miller forcefully states that, in the final analysis, it is his opinion that only clinical evidence is reliable in the matter just discussed and with reference to the evaluation of the focal infection principle as a whole. He admits that bacteriologic and experimental methods have a place in the study of this problem, but he also insists that the information derived from such sources is sec-

ondary in importance to that obtained by clinical methods, carefully and adequately controlled. Clinical evidence of this kind is difficult to obtain, as already stated, but in the long run it is the sort of information upon which the fate of the focal infection principle will be decided; a decision that even now is in the process of formulation. It is either a current fad or a valuable principle which will persist in the control and treatment of many forms of disease.

THE PULPLESS TOOTH PROBLEM.

With respect to the pulpless tooth there is no such common agreement, since clinicians, laboratory investigators and radiographers are divided into two widely divergent schools of thought, especially with reference to the x-ray negative, pulpless tooth. The sources of information that serve as a basis for such diverse opinions and practices are in part similar to those just mentioned in the preceding paragraph; they are clinical, bacteriologic, radiographic and histologic in character. In general, it may be said that the information obtained by radiographic and histologic examination of pulpless teeth is the substantial foundation for opinions and practices based on the proposition that x-ray negative pulpless teeth do not harbor infection and are not primary foci.

The virtues and limitations of both the x-ray film and the histologic preparation are thoroughly understood. The information supplied by both is reliable and exact and there is a high degree of correlation between the two. On the other hand there is no agreement amongst the bacteriologists with respect to either the methods used or the interpretation of their results. From bacteriological examination such conclusions as the following have been reached: all pulpless teeth are infected; the majority of pulpless teeth are infected; most pulpless teeth, if not infected, will become infected in the not distant future; x-ray negative pulpless teeth are generally not infected. Some bacteriologists are prone to consider all pulpless teeth as primary foci of infection or at best as potential foci of infection. Clinical information may be interpreted favorably to any of these points of view, depending almost entirely upon the prejudices of the writer or observer.

The mouth is a particularly difficult field in which to do bacteriological work, indeed from the standpoint of bacteriology it is still a relatively unknown quantity. However, it is known that the crowns and necks of the teeth are bathed in fluid literally teeming with bacteria, and this is especially true of the region at the junction of the gums and teeth, the gingival crevice. There may be great variations in actual number, nevertheless the actual number is always significantly great. Under such conditions complete sterilization of the field is very difficult, much more difficult than for almost any other part of the body. The act of forceps extraction is of such a nature as to favor the aspiration of bacteria from the gingival region progressively deeper into the socket as the tooth is gradually loosened, before its actual delivery. With but

few exceptions all of the bacteriologic information has been collected from the examination of extracted teeth.

In most instances material for cultures has been obtained from extracted teeth, which were wrapped in sterile gauze and then transported to the laboratory. Such material may consist of: scrapings from the apical portion of the root or the adherent soft tissue; from matter obtained by shaking the snapped off apex in physiological salt solution containing sand; from material obtained by grinding up the apical fragment in a sterile mortar with a sterile pestle; or blood aspirated into a sterile pipette from the socket immediately after extraction; or from the root of the tooth after sterilization by dipping the tooth in alcohol and burning off the fluid repeatedly. In the last method (dipping in alcohol and burning), the material used for culturing may be obtained from the root fragment in any of the ways described above or by the use of a sterile barbed broach inserted into the root canal after cutting off the apex.

The results obtained by these various methods of examination have been tabulated on the basis of whether or not some effort has been made to sterilize teeth after extraction. This also divides the figures into groups in which there is a relatively high degree of correlation between data for all the workers within each group; however, since the results of the two groups differ radically and the differences cannot be reconciled, one or both of the methods must be unsound. Lenberg found that as a rule growth could be obtained from blood aspirated from the tooth socket after extraction; in other words, by the time the tooth is lifted out of the socket by the forceps the fluid in the socket is already contaminated. Lenberg, Henry et al., Nichols, Jiminez, Cramer and others report that cultures made from scrapings of the apical portions of the roots of extracted teeth, including even vital, healthy teeth, were positive, containing streptococci and other forms of bacteria. This can only mean that these teeth became contaminated during extraction if they were not already infected. Haden made cultures of extracted teeth in both brain broth and tall tubes of brain agar. Nearly half of all the teeth cultured, regardless of whether they had vital pulps or were infected, yielded bacteria in the brain broth tubes. From that one may conclude that as many as one-half of the teeth in this series became contaminated during the act of extraction. Although he reported typical variations in the proportions of positives in his different groups, yet the significant fact is that the percentage of positives was quite high in all groups. The extractions were performed by two operators using an exact technic and the extractions were limited to the anterior teeth. Therefore, even careful extraction of selected teeth does not eliminate wholly the matter of contamination. The chances for contamination are quite high and the problem has to do with the degree of contamination and its relative importance.

Rosenow makes no effort to eliminate the contaminating organisms from his cultures. Since his data are largely concerned with

other matters, it is not possible to tabulate them accurately, but he has stated repeatedly that as yet he has not examined a pulpless tooth that did not yield pathogenic bacteria. He is confident that he can distinguish between contaminating organisms and pathogenic bacteria by the differences in their behavior when inoculated into rabbits and other experimental animals or by other methods such as the migration rates of the isolated bacteria in electrical fields.

Haden attempted to estimate the factor of contamination by growing his cultures in tall tubes of brain agar. The tubes were inoculated while the agar was liquid, they were shaken well to distribute the bacteria, and the number and location of the colonies estimated after incubation at body temperature. He noted that the number of colonies was relatively small in cultures made from vital teeth and high in all infected and pulpless teeth. He arbitrarily selected ten colonies per tube as the border line between the presence and absence of infection. As these facts cannot be shown in the general table, a separate condensed table is shown herewith for his data.

HADEN'S DATA.

Classification	No.	—Broth Cultures—		Agar Cultures in Number of Colonies Per Tube		
		Pos. Per Cent	Neg. Per Cent	1 or More Per Cent	10 or More Per Cent	Over 100 Per Cent
Vital Teeth	400	55.0	45.0	14.5	4.8	1.2
X-ray Negative Pulpless Teeth	600	83.8	16.2	56.7	46.2	25.7
X-ray Positive Pulpless Teeth.	500	91.0	9.0	73.4	62.8	44.2

It is indeed difficult to estimate the significance of such figures. Haden concluded that both X-ray positive and negative teeth should be considered as primary foci and that the X-ray negative pulpless teeth were only little less of a menace than those which were positive. He also felt that radiographic examination was of little help in arriving at a decision as to what teeth were infected.

Rhoades and Dick examined 29 X-ray negative pulpless and 14 vital teeth, using a quantitative method so that their results could be recorded in numbers of bacteria recovered per c.c. of cultured material. All but one of their cultures were positive for both vital and pulpless teeth. The single exception was a culture from a vital tooth. In their report no radiographs are reproduced and there is no statement made with respect to how or by whom this part of the investigation was made. The corner stone of their argument is based on the much higher average count (759,574) for the pulpless teeth cultured as compared with the vital teeth examined. If one excludes the counts for the seven pulpless teeth in which very high counts (above 100,000 per c.c.) were recorded, there is not very much difference in the average figures for the two groups (13,124 and 1,876). They selected 10,000 bacteria per c.c. as the critical mark for recording infection, as this was somewhat greater than the highest count for any vital tooth (8,800). Even though

fourteen pulpless teeth had lower counts than this and thirteen had lower counts than the highest vital tooth, they do not hesitate to rate the pulpless tooth as an infected tooth and to discount the value of the information supplied by radiographic examination. In the light of the preceding analysis and the subsequent discussion of this vexing problem of the pulpless tooth, it must be concluded that their deductions are not justified.

Other investigators have attempted to exclude contaminating organisms by agglutination tests, or by growing the isolated bacteria on the patient's whole blood, by complement deviation tests, etc. One may have great respect for work of this kind without allowing it to confuse the problem and without accepting it as positive evidence for the wholesale condemnation of pulpless teeth. In spite of the seeming validity of the contention of Haden, Austin and Cook and others that they have adequately estimated the degree of contamination and that it is relatively insignificant, it must be concluded from their work alone that such is not the case. Where careful selection of the teeth is made for study and unusual precautions are taken in the extraction and culture of vital teeth, results comparable to theirs can be secured. Any attempt to compare random pulpless anterior or other teeth with the preceding is statistically unsound.

RESULTS OF BACTERIOLOGIC EXAMINATION OF TEETH
WITHOUT STERILIZATION AFTER EXTRACTION.

All Figures in Percentages.

Author	Number of Teeth	Teeth Without Disease		X-ray Negative Teeth		X-ray Positive Teeth	
		Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Rosenow .....		..	..	100	0	..	..
Haden	1307	54	46	83	18	91	9
Austin and Cook.....	300	5	95	84	16	94	6
Rhoades and Dick.....	43	93	7	100	0	..	..
Meisser and Brock.....	107	..	..	100	0	100	0

RESULTS OF BACTERIOLOGIC EXAMINATION OF TEETH
AFTER EXTRACTION AND BURNING OFF ROOTS
WITH ALCOHOL.

Author	Number of Teeth	Teeth Without Disease		X-ray Negative Teeth		X-ray Positive Teeth	
		Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Cramer	149	15	85	12	88	82	18
Henry, Sniffen and Doyle..	219	..	..	30	70	80	20
Nichols	68	..	..	..	..	79	21
Lenberg	62	20	80	21	79	71	29

The work of Henry, Sniffen and Doyle has had but scanty recognition. They conducted a series of careful experiments, including the inoculation of the pulps of teeth with specific, easily

identified organisms before attempting to collect any data. They concluded that most teeth were grossly contaminated during extraction and that dipping the teeth in alcohol and burning, even if repeated many times, did not kill organisms within the pulp. Their tests have been repeated by Nichols, Lenberg and others and confirmed. Their data cannot be accurately tabulated although they make the definite statement that the degree of correlation between their bacteriological and radiographic examinations is 75%. All of the investigators, using some method involving the sterilization of the tooth before culture, state definitely that such a method of culture is not wholly faultless in that the number of negative results is higher than is warranted, especially in the X-ray positive group, and that this largely accounts for the discrepancies between the results of bacteriologic and X-ray examination. Since not all of the shadows seen in the X-ray film are the result of an infectious process, such as cysts, a further increase in the lack of correlation is accounted for. In determining the status of the pulpless tooth, it would seem that results of the bacteriologic examinations, as performed by this second group of bacteriologists, may be considered as a substantial foundation for clinical practice and that the data submitted by the first group do not justify the wholesale condemnation of either the X-ray pulpless tooth or the radiographic method of examination.

A recent very interesting study of the distribution of oral streptococci by Fish and Maclean tends to strengthen the conclusions reached in this discussion. These authors also emphasize the ease with which organisms are pumped into the tooth socket by the rocking of the tooth during extraction and confirm their argument by carefully planned experiments. They find that the streptococci are strictly limited in location within regions that are definitely necrotic, and fail to penetrate the granulation tissue surrounding the apex of an infected dead pulp. "Nevertheless, if their toxins have caused local bony changes, they are dangerous." One of their illustrations is reproduced in Figure 1736.

Additional evidence for the validity of this conclusion has been obtained by studies of teeth by histologic examination. Skillen studied 250 teeth, all of which were pulpless and X-ray negative, and in only six of these did he find any evidences of infection. The degree of correlation between histologic and X-ray examination is therefore very high, 97%. This is what may be anticipated as the histologic method depicts all changes whether the process is infectious or otherwise. Other investigators have corroborated these findings.

Pulpless teeth, however, have a relatively high ratio of apical infection as can be seen in the Black tabulation included in this chapter. It is also clear from the same source that teeth which seem to be well filled, as evidenced by the radiograph, have a much lower incidence of apical infection. This seems to indicate quite clearly that adequate root canal technic may reduce the percentage of

periapical infection from one of as high as 63% to as low as 9%. Skillen's examination of pulpless teeth in serial cross sections discloses the fact that failures in root canal technic are quite as common in the transverse dimension as they are longitudinally. Probably the presence of necrotic pulp material is more likely to invite subsequent periapical infection than failure to bring the apical end of the filling reasonably close to the apex. These two discrepancies in root canal treatment, especially in the fillings inserted years ago, before attention was directed to these facts, may account for the high percentage of periapical infections associated with pulpless teeth in the Black tabulation. Rickert and other observers have noted that periapical infection is more common about pulpless teeth which have not been adequately treated.

SOURCE OF BACTERIA FOUND IN PERIAPICAL INFECTIONS. There are no data to indicate definitely the source of the bacteria causing infections of pulpless teeth. It is believed that many such infections are due to inadequate treatment at the time the canal is filled and that they are residual in character. Hasegawa produced some data which indicated that bacteria may gain access to the apical region from neighboring infected peridental tissues. Finally there is a growing opinion that pulpless teeth are particularly susceptible to infection by the hematogenous route and that, therefore, many periapical infections are secondary rather than primary. There is very little direct evidence as to this last contention, although some data will be offered a little later in support of a belief that the bacteria, isolated from the lesions of oral infections of persons otherwise in good health, are not as virulent for experimental animals as those isolated from mouth infections of those suffering from infectious forms of arthritis, nephritis, etc.

Patients generally consult physicians and frequently dentists, only after the secondary infection has become well established. By this time ample opportunity has been afforded an invading organism to dominate the situation and perhaps replace other bacteria in older infectious lesions. They may become similarly established in regions particularly susceptible to invasion, as the periapical region of pulpless teeth. Such an assumption is wholly in harmony with both sets of conditions discussed above, that is, the high incidence of infected pulpless teeth and the greater virulence for experimental animals of the bacteria recovered from the oral lesions of those suffering from secondary types of focal infection.

THE PULPLESS TOOTH ; CONCLUDING STATEMENT.

If it were not for one situation, the final statement on the pulpless tooth could be written with great confidence. However, it is a very disturbing fact that in occasional cases radical improvement is noted in the secondary lesion following the extraction of x-ray negative pulpless teeth. In some instances, this improvement is even more startling than that observed following the removal of

obvious oral primary foci. Haden observes very interestingly: "The radiographic findings taken as evidence of infection is in large part evidence of the patient's resistance to infection. . . . It seems most probable that a pulpless tooth, which shows no evidence of resistance and yet harbors bacteria at the apex, is more apt to be a focus of systemic disease, since there is no barrier to bacteria and their products."

In this connection, it does not seem probable that an active focus can exist without some tissue change. Such tissue changes may be of a diffuse character and cause but little modification of the tooth and bone, a condition that is difficult to interpret in the x-ray film. It seems likely that the criticism should be directed at radiographic technic rather than at the pulpless tooth. Oral radiographic diagnosis demands a much better service than is routinely provided for it in hospitals and medical clinics. In the final analysis, however, this situation may occasionally demand the sacrifice of a pulpless tooth, even though adequate radiographic examination has disclosed no changes in either the tooth or the adjacent bone.

Apparently, the only conclusion that can be accepted is that the menace of the pulpless tooth is insignificant as compared with its merits in properly selected cases, if the root canal is treated and filled adequately from the standpoint of preventing infection. As Miller says; "It is scarcely probable that the pulpless tooth is the sole focus responsible for generalized infection. There are those who might claim that extraction of the pulpless tooth should be performed as a preventive measure. The burden of proof that such a tooth is a menace rests on those who take this position. The ruthless removal of a useful organ for the purpose of preventing a possible future calamity, unless based on adequate evidence, should not be tolerated. Such evidence, to the best of my knowledge does not exist."

If these situations are kept in mind, and patients with pulpless teeth are willing to cooperate with the dentist by submitting to periodic examinations, pulpless teeth may be so treated as to perform their proper service without undue menace to health. Properly filled root canals are less hazardous than extremely large restorations, which endanger the vitality of the pulp, oftentimes causing its death without subjective symptoms of consequence.

Data with reference to focal infection were accumulated by Mela, in a rather unusual study. He followed Rosenow's method accurately up to the point of the examination of the inoculated animals. To determine the relative importance of the lesions in the rabbits, he made histological preparations of the organs and tissues and total counts of the bacteria recovered in terms of bacteria per gram of tissue examined. He used four strains, stomach-duodenal ulcer, arthritic, nephritic and those taken from oral infections of people otherwise in good health. The most interesting feature of this study is found in the statement that the

strains isolated from the mouths of those in good health were, in comparison with the three other groups, very feebly pathogenic for experimental animals. The averaged results are shown in the accompanying table.

HISTOLOGICAL LESIONS IN RABBITS PRODUCED BY INOCULATION OF MASSIVE DOSES OF STREPTOCOCCI INTRAVENOUSLY.

The Severity of the Lesions Is Graded from 0 to 4 and the Results averaged for Each Strain of Bacteria Used.

Disease Associated With Strains Used	Liver	Kidney	Spleen	Joints	Stomach-Intestine
Stomach-Duodenal Strains, 15 Cases..	1.07	0.73	0.54	0.54	0.20
Arthritis Strains, 14 Cases.....	1.07	1.07	0.79	1.33	...
Nephritis Strains, 15 Cases.....	1.47	2.00	0.67	0.67	...
Oral Infection Strains, Subjects in Good Health, 8 Cases.....	1.00	1.00	0.38	0.38	...

QUANTITATIVE BACTERIAL COUNTS PER GRAM OR C.C. OF MATERIAL CULTURED.

Character of Strains Used	Liver	Kidney	Spleen	Joints	Stomach	Blood
Stomach Strains	1,143	1,072	720	1,391	708	35
Arthritis Strains	733	879	565	2,671	...	131
Nephritis Strains	1,449	2,369	1,268	1,216	...	353
Oral Strains, Persons in Good Health.	268	387	261	347	...	11

In the histological examination, the severity of the tissue involvement was graded in figures of 0 to 4; if there were no change at all, it was recorded as 0, if the change were very slight, 1, and so on. It would seem quite significant that the organisms isolated from the mouths of persons in good health had very slight ability to invade the tissues of the animals inoculated, as discussed earlier.

Massive inoculations of animals with bacteria of the types discussed above cause histological changes in all organs and tissues. These variations from the normal picture are rather constant for all the tissues and bacterial strains involved. The two exceptions are found in the kidneys of the animals inoculated with the nephritis strains of bacteria and in the joint tissues of the animals injected with the arthritic type of organisms. The strains of bacteria recovered from oral infections in people in good health are destroyed by the inoculated animals much more rapidly, with less damage to the tissues, as shown by histological examination. This indicates that these strains of bacteria are correspondingly less able to cause disease.

DIAGNOSIS OF FOCAL INFECTION.

The diagnosis of focal infection and the location of the primary foci are matters of great importance and have received much attention. A variety of methods have been proposed, including differential blood cell counts, chemical examination of the blood, especially for its uric acid content, inoculation of animals, aggluti-

nation of bacteria by the patient's serum and complement deviation tests. Holman rejects all of these; he also includes in his blanket rejection Rosenow's method of elective localization, as well as the pathogen-selective method of Solis-Cohen. With respect to oral infection, this leaves the clinician with only two diagnostic assets, the radiograph and careful clinical examination.

This places a great load of responsibility upon clinical examination and upon the ability of the dentist to make and interpret radiographs, also upon the experience and judgment of the clinician; qualities for which there is, at the present time, no adequate substitute. There is no doubt but that the more important of these is the clinical examination and history. On the other hand, the radiograph, if properly made, supplies indispensable information. This implies well made films and, in questionable cases, multiple exposures at different angles. A criticism of the present radiographic situation, so far as dental films are concerned, is included in the preceding chapter on the treatment of chronic periapical infections.

CLINICAL MANAGEMENT OF ORAL FOCAL INFECTION.

The clinical management of focal infection, as far as the mouth is concerned, has to do with two situations: treatment of the mouths of patients suffering with diseases of the focal infection type, including decisions as to what teeth to extract; and the prevention of oral primary foci, by a comprehensive program of patient and practice management with the patient's general health as its primary objective. The first has to do with a careful search for all possible regions of infection and their elimination by some form of treatment. The second is the thesis to which this entire volume is addressed.

INDICATIONS FOR EXTRACTION. The decision as to the teeth which should be extracted, especially in questionable cases, is not easy to make. The correct conclusion is based on the facts disclosed by the mouth examination, the relationship of these conditions to the status of the rest of the teeth and the investing tissues, the health of the patient and, oftentimes, the advice of the attending physician.

The condition of the patient's health and the physician's advice determine the general program that is to be followed, whether radical or conservative. A conservative decision is indicated where the patient is in good health and relatively immune to mouth and other infections. In cases of persons severely ill with heart disease, active diabetes, advanced anemias, leukemia, acute infectious processes, the acute stages of secondary focal infection, etc., it should be the rule to certainly eliminate all infection about the teeth, even though this may include the removal of a few treated teeth which appear to be negative, both in the radiograph and as a result of careful clinical examination. If a number of teeth are to be extracted, a definite program should be formulated, with a

notation of the particular teeth to be removed at each visit. The number to be removed at one time should be limited in consideration of the condition of the teeth and the patient's health. This program should be ratified by the physician. A serious relapse, or a fatal result, may follow any other plan. Individuals suffering from asthma, those subject to severe allergic reactions, those with a bad family history with respect to arthritis, heart disease and other degenerative diseases of a similar character, and those in the early phases of secondary chronic focal infection, usually call for the most thorough elimination of mouth infection. The reason for this decision is based largely on the assumption that the resistance of this type of individual to bacterial infection and its consequences is low, and that each additional focus of infection, whether primary or secondary, adds to the burden to be carried, rather than that such a condition is of casual significance.

Local oral conditions which influence extraction are discussed in the preceding chapter.

CONCLUSION.

From the standpoint of the dentist one must conclude that the principle of focal infection has greatly increased both his responsibilities and his opportunities to maintain the health and well being of his patients. It has very materially broadened the scope, both as to time and content, of his professional and pre-professional training. As a guiding principle, it serves to evaluate not only therapeutic methods in general, but also can be applied to the solution of the problems of diagnosis and treatment planning in individual cases.

As to the future, one can only recall the fact that this principle of focal infection has survived nearly a quarter of a century of highly active research and clinical trial and, as a consequence, has received world wide recognition as a valuable clue to the solution of many therapeutic problems of diagnosis and treatment. Radical opinions with respect to its acceptance as a working principle are heard less frequently with the elapse of time. If earlier activities were concerned chiefly in attempts to demonstrate its dangers, it should be said that there is now a disposition to deal rather with its limitations.

Haden's recent comment on the changing opinion with respect to focal infection and its etiological significance is quite pertinent at this stage of the discussion. Indeed, it is even more to the point, since he has been considered as having taken a rather radical position with respect to the menace of oral infection. He says: "It is true some conditions which were formerly thought to be due to focal infection are now known to arise from a different source; for instance, we are just beginning to appreciate the clinical importance of nutritional deficiency disease. Many of the cases of neuritis, which formerly were thought to be related to bacterial infection, are now known to result from dietary defects. We are

appreciating more and more the soil of disease, and thus consider seriously the relationship between the chemical makeup of the patient and the factors which are imposed from without, such as focal infection. Further study seems to indicate that entirely different etiological factors may be responsible for some diseases which were formerly considered to be due to bacteria. Thus the trend of opinion suggests that acute rheumatic fever and chronic rheumatoid arthritis may be due to a filterable virus rather than immediately to the streptococci and other bacteria."

This statement, considered in the light of earlier quotations from Miller and the brief succeeding discussion, indicates the current trend of thought with reference to focal infection as a whole, as well as its oral phases. Opinion is being consolidated in a somewhat conservative form, but there is no indication that the principle will be wholly abandoned and completely rejected. It should be used with good judgment, without prejudice and without slavish devotion to either extreme point of view.

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GLOSSARY OF TECHNICAL TERMS

ABRASION. Wear of the surfaces of the teeth as a result of their use in mastication. The condition to which the term is applied is usually a wear of abnormal amount which does not represent a corresponding abnormal use, the excessive wear being due to some unknown influence.

ABSCCESS. A collection of pus in a cavity formed within the tissues of the body. A *periapical* or *alveolar abscess* occurs within the tissues about the apex of the root, as a sequella of the death of the pulp. A *lateral pericemental abscess* occurs within the tissues at the side of a root, usually in the depth of pockets in cases of chronic suppurative pericementitis.

ABSORB. To suck up, to take in, to remove by an absorbent.

ABSORBENT. An agent that takes up moisture. A specially prepared cotton—absorbent cotton, spunk, or bibulous paper, for drying cavities in teeth.

ABSORPTION. The taking into the tissues, through the medium of the lymphatics and blood stream, of any material in suitable form, including the removal of waste or pathological products; the taking up of gases by liquids or solids; or of liquids by solids. This term has been very generally used synonymously with resorption.

ACCELERATOR. Anything which hastens a chemical or physical reaction.

ACCRETION. Addition by growth, or by deposit, little by little; may be either amorphous, i. e., leaving no lines showing the form of growth; or stratified, showing lines of increase. The enamel of the teeth when reduced to microscopic sections in certain directions shows accretion lines or layers of added material. See Lines of Accretion.

ACCRETION LINES. See Lines of Accretion.

ADHESION. The union of substances that differ in their nature, as: adhesion of glue to wood, paste to paper, etc. To unite bodies by their surfaces.

ADSORB. To condense and hold a gas on the surface of a solid.

AFTER CONDENSATION. Such condensation of the surface of a gold foil restoration as may be made after the restoration has been otherwise completed.

AGGLUTININ. Any one of a class of substances, apparently protieds, occurring in animal organisms, and producing agglutination.

ALLOTROPIC. Pertaining to a change in physical form or property shown by the elements or their compounds without change in chemical composition.

ALLOY, n. A metallic material composed of two or more metals.

ALLOY, v. The act of compounding an alloy.

ALVEOLAR ABSCESS. See abscess.

ALVEOLAR PROCESS. The projection of the maxillary bones which envelops the roots of the teeth, and in which their alveoli are formed.

ALVEOLUS. (Pl. Alveoli). A socket: The cavity in the process of the maxillary bones in which the root of a tooth is fixed.

AMALGAM. An alloy, one of the constituents of which is mercury.

AMALGAM ALLOY. The metallic substance, in the form of shavings or filings, which is mixed with mercury to form a dental amalgam.

AMELIORATION. Improvement.

AMORPHOUS. No regularity of molecular arrangement in a solid; non-crystalline.

AMPUTATION. The cutting away, or removal of a part, as one root of a multirooted tooth.

ANALGESIA. Loss of sensibility to pain.

ANALGESIC. Having the property of relieving pain.

ANCHORAGE. The points of fixation of restorations or artificial crowns or bridges.

ANESTHESIA. Loss of sensation as a result of interference with the normal action of nerves. *Conduction anesthesia*; the injection of an anesthetic into and around the nerve trunk supplying the region. *Infiltration anesthesia*; produced by injecting an anesthetic into the subcutaneous tissue. *Pressure anesthesia*; the application of an anesthetic with sufficient pressure to force it into the tissue, as into the dentinal tubules, or through the tubules into the dental pulp. *Topical anesthesia*; produced by applying the anesthetic directly to the tissue, as to the dentin.

ANESTHETIC. A drug capable of producing insensibility to pain.

ANGLE. The line, or point, where two or more surfaces of the teeth or walls of cavities join. The mesial and buccal surfaces join in the formation of the mesio-buccal angle; a line angle. The mesial, buccal and occlusal surfaces join in the formation of the mesio-bucco-occlusal angle; a point angle. The so-called angles of the teeth are generally smoothly rounded but are named as if they were definite angles.

ANGLES OF SHANKS OF INSTRUMENTS. Named according to number and direction of angles, as monangle, binangle, triple-angle, contra-angle, etc.

ANISTROPY. Condition of exhibiting different properties when tested in different directions.

ANNEAL. To reduce brittleness and increase toughness by heat treating; to recrystallize; to make non-cohesive gold foil cohesive.

ANODYNE. A drug or remedy which relieves pain.

ANTISEPTIC. A substance or remedy which opposes the development of septic conditions; that opposes, delays, hinders or prevents those decompositions in which poisonous, septic, or disease-producing compounds are formed; such as the putrefactions, fermentations, etc.

APEX. The terminal end of a cone; a conical end. The terminal end of a root of a tooth.

APICAL. Pertaining to the apex or conical endings of the roots of teeth.

APICAL FORAMEN. The minute opening of the pulp canal at the apex of the root of a tooth.

APICAL SPACE. The space between the bone, or wall of the alveolus, and the apex of the root of a tooth. This space is filled with the soft tissues of the peridental membrane, and is the seat of alveolar abscess.

APPROXIMATE. Next to, nearest to. To draw near to. Occasionally employed to designate the distal or mesial surface of a tooth. See Proximal.

ARCH. An arc or portion of a circle. Any object in nature or art which is curved, like an arc. The dental arch, the arrangement of the teeth in a bow shape or arc.

ASEPTIC. The condition of freedom from sepsis or freedom from microorganisms which might possibly produce a condition of sepsis.

ASEPTIC WOUND. A wound not infected with microorganisms.

ASPHYXIA. Suspended animation as a result of suffocation.

ATROPHY. "Latin, *Atrophia*, without nourishment. A, without; *trophia*, nourishment."—Webster. A result of defect of, or a failure of, nutrition of a part which limits its formation. A diminution of the size of a part, or a wasting due to defective nutrition. Of the teeth: a failure in the formation of certain parts of the enamel and dentin because of a failure of nutrition at the time those particular parts should have been formed. This results in a dwarfing of certain parts of the tooth and causes it to be malformed. See Hypoplasia.

ATROPHY MARKS. The peculiar marks left on the teeth by reason of a failure of nutrition during their development.

AXIAL. Pertaining to the long axis of a tooth. See Axial Surface.

AXIAL ANGLES OF TEETH. The line angles that are parallel with the long axes of the teeth are called axial angles. They are the mesio-buccal and mesio-labial, disto-buccal and disto-labial, mesio-lingual and disto-lingual angles.

AXIAL CAVITIES. Cavities beginning in any of the axial surfaces of the teeth; as the mesial, buccal or labial, distal and lingual surfaces.

AXIAL SURFACES. Those surfaces of the teeth that are parallel with their long axes. They are labial or buccal, lingual, mesial and distal surfaces.

AXIAL WALL OF CAVITIES. That wall of a cavity in an axial surface of a tooth in a plane parallel with the surface in which the cavity is prepared, and nearer to that surface than to the opposite axial surface of the tooth.

AXIAL WALLS OF PULP CHAMBERS. Those walls that are parallel with the long axes of the teeth; the mesial, distal, buccal and lingual walls.

AXIO-BUCCO-LINGUAL PLANE. A plane passing through any part of a tooth from buccal to lingual parallel with its long axis. See Vol. II, Figure 282.

AXIO-LABIO-LINGUAL PLANE. A plane passing through any part of an incisor or cuspid tooth from labial to lingual parallel with its long axis.

AXIO-MESIO-DISTAL PLANE. A plane passing through any part of a tooth mesio-distally parallel with its long axis. See also mesio-distal plane. See Vol. II, Figure 283.

BELL CROWNED. A tooth in which the mesio-distal diameter of the crown is much greater than that of the neck.

BEVEL. To cut a bevel angle; to slope the edge or surface of. To deviate or incline from an angle of 90 degrees, as a surface; to slant. (Webster.) To slope the outer edge of the surface of the enamel wall of a cavity. See Vol. II, Figure 307. To grind the flat side of the blade of an instrument at an inclination to form a cutting edge.

BIBEVELED. Having a bevel on two sides of a blade. Bibeveled to a point, as in drills, for cutting while being rotated.

BONE CORPUSCLES. The soft cells that persist in bone after calcification.

BORDER OF THE ALVEOLAR PROCESS. The thin edge of the alveolar process surrounding the necks of the teeth.

BRINELL HARDNESS NUMBER. (abbr. B.H.N.). A measure of hardness of a structure, obtained by determining the unit stress on the surface of an indentation made by a hardened steel ball of a specified diameter under a specified load.

BRITTLENESS, n. Lack of ability to withstand permanent deformation; lacking in plasticity; opposite of toughness.

BROWNIN. A term applied to the coloring matter which is often found in many defects in the teeth, particularly in the deeper portions of enamel whorls or pits in the enamel, and in the otherwise open spaces between the enamel rods in cases in which the cementing substance, which is normally between the rods, is wanting.

BUCCAL. Pertaining to the cheek; toward the cheek; next to the cheek, etc.

BUCCAL SURFACE. The surface of a tooth next to the cheek.

BUCCO-GINGIVAL RIDGE. A prominent ridge near the gingival line on the buccal surface of the temporary molars. It is especially prominent on the temporary first molars.

BUCCO-LINGUAL. From the cheek toward the tongue; as the bucco-lingual diameter of the crown of a lower first molar.

BUCCO-LINGUALLY. A direction from the buccal toward the lingual.

CALCIFIC. Containing salts of calcium.

CALCIFICATION. The act of depositing calcific matter or calcium salts during growth. The bones and teeth become calcified. Also pathological calcifications occur in several parts of the body.

CALCIFICATION LINES OF RETZIUS. The accretion lines in the enamel were first described by Retzius. See Lines of Accretion.

CALCO-GLOBULIN. A globulin which contains calcium salts. This term is applied to a mass of soft material, which may be deposited on the teeth and eventually become hard.

CALCULUS. A stone-like mass, composed chiefly of lime salts. Salivary calculus is deposited from the saliva; serosal calculus from the excretions from inflamed tissues.

CAPPING. A covering, as with a cap. A term applied to the operation of placing a covering over an exposure of the pulp of a tooth.

CARIES. Latin, caries. Only one form of the noun is used in English; it has no plural. The word was imperfect in its inflections in the Latin. Rottenness, moldiness, decay, as of wood or timber. Anthon. Ulceration of bone; a process in which bone disintegrates and is carried away piecemeal, as distinguished from necrosis in which it dies in masses. Webster. In dentistry: Decay of the teeth, in which cavities are formed in them by gradual decomposition.

CARIOUS. A condition of tissue like enamel or dentin, or, of a tooth, affected with dental caries. In medicine it refers to a cellular disintegration of bone.

CARNIVOROUS. Animals that eat flesh.

CASTING FLASK (flask, casting ring), n. A container used in casting for confining the investment while forming the mold.

CAVITY. An opening in any substance which has but one outlet or is entirely closed. Any opening into a tooth formed by caries or artificially made.

CAVITY, COMPLEX. A cavity involving two or more surfaces of a tooth, as a disto-occlusal cavity.

CAVITY NOMENCLATURE. In dentistry, a system of nomenclature applied to cavities in teeth. Under this term is included all of the names of cavities, names of cavity walls, of angles of cavities and the terms of cavity description, together with the rules of their use.

CAVITY PREPARATION. Those operations necessary in forming cavities in teeth for the reception of restorations.

CAVO-SURFACE ANGLE. The angle formed by the junction of the cavity wall and the surface of the tooth. Used particularly in indicating the form to be given this angle by beveling or otherwise, in any particular part of the line of the enamel margin. See Vol. II, Figure 280.

CEMENT, n. An adhesive material, for the cementation of inlays and crowns and for temporary restorations.

CEMENTAL CURVATURE. The deviation of the cemental line from the horizontal in its course around the tooth; especially the incisors and cuspids.

CEMENTAL LINE. The line of junction of the outer surface of the cementum with the surface of the enamel. It is the rootwise boundary line of the crown of the tooth.

CEMENTAL MARGIN. The portion of the crown, or of a surface of the crown of a tooth next to the cemental line.

CEMENTOBLASTS. Cells within the peridental membrane which build cementum.

CEMENTOCLASTS. Cells which resorb cementum, and oftentimes dentin also.

CEMENTO-ENAMEL JUNCTION. The cemental line.

CEMENTUM. A special calcified tissue which covers the roots of the teeth. It has lacunæ and canaliculi, but differs from bone in having no Haversian canals.

CENTIGRADE. One hundredth part of a circle. An angle of twenty-five centigrades is a right angle and equals ninety degrees of the astronomical circle, or eight points of the mariner's circle. One centigrade equals three and six tenths (3.6) degrees.

CENTRIC OCCLUSION. The relation of the upper to the lower teeth when the jaws are closed and at rest.

CERVICAL. *a.* Pertaining to the cervix or neck. Used formerly in a sense somewhat similar to that in which gingival is now used. See Gingival, also Cemental line and Cemento-enamel junction.

CERVICAL GLANDS. The superficial lymphatic glands in the neck, situated anteriorly to the sterno-clido-mastoid muscle.

CERVIX. *n.* Neck. The portion of the crown of the tooth near its junction with the root has been called the cervix, or neck.

CHILDHOOD PERIOD OF THE PERMANENT TEETH. The period from the first appearance of the permanent teeth until their roots are fully completed, except the third molars. See Vol. III, page 113.

CLAMP FORCEPS. A special forceps for placing the rubber dam clamp.

CLAMP, RUBBER DAM. An instrument made to set on teeth to hold the rubber dam.

CLEAVAGE. The line of easy splitting of crystalline or stratified substances. To split along the length of the grain; as in splitting wood. The act of splitting the enamel in a certain direction following the length of the enamel rods which form its cleavage lines.

CLEAVE. To split.

CLEOID. (From cle, old Saxon for claw, and oid, like.) A claw-like instrument used in excavating cavities.

CLOT. *n.* A soft, semi-solidified mass, as of blood or lymph.

COHESION. The act or state of sticking together; close union. That form of attraction by which the particles of a body are united throughout the mass, particle to particle. This must be distinguished from adhesion, which unites bodies by their surfaces only. It is only bodies that have a common property, as simple elements, compounds or alloys formed of them, that cohere.

COHESIVE. A property of annealed gold (foil or crystal) which causes separate particles to stick to one another, as they are welded, when placed in contact by heavy hand or mallet pressure.

COHESIVE GOLD. Gold in the form of foil or crystals, the surfaces of which are clean and free from condensed gases or salts so that they may be brought into actual contact. Gold foil or crystals in which the welding property is partially or fully developed.

COLD WORK. To permanently deform a body below its annealing or recrystallization temperature.

COLLOID. A translucent, yellowish, homogenous material of the consistency of glue, found in the cells and tissues in a state of colloid degeneration. A substance slowly diffusible, rather than soluble, in water and capable of passing through an animal membrane.

COMPLEX CAVITY. A cavity involving two or more surfaces of a tooth, as a disto-occlusal cavity.

COMPRESSIVE STRESS. An internal induced force which tends to oppose the shortening of a material in a direction parallel with the direction of the stress.

CONDENSER. An instrument for condensing gold, amalgam or other material in cavities in the teeth. Syn.: Plugger.

CONDUCTIVE ANESTHESIA. Loss of sensation caused by the injection of an anesthetic into and around the nerve trunk supplying a region.

CONSERVATION. The act of preserving, guarding or protecting; keeping in a safe state; the conservation of the teeth.

CONTACT POINT. The point on the proximal surface of a tooth which touches a neighboring tooth.

CONTEMPORANEOUS. Living, occurring or existing at the same time; said of persons, events or things.

CONTEMPORANEOUS ACCRETIONAL DYSTROPHY. A deformity occurring along the lines of accretion in all of the parts (of the teeth) in process of development at a particular time, or during a period of malnutrition.

CONTEMPORANEOUS CALCIFICATION LINES. The portions of the several teeth which are undergoing calcification at the same time. A representation of the portions of the several teeth undergoing calcification at the same time by drawing lines over pictures or diagrams of the teeth.

CONTOUR. *n.* The line bounding a figure or body, as the contour of a tooth.

CONTRA-ANGLE. Angles formed in the shank of an instrument, first backward from the direction of the cutting edge and then forward to form the blade in order that the working edge may be placed near the long axis of the handle. There are binangle and triple-angle contra-angles.

CONTRA-ANGLE HAND-PIECE for the dental engine. A hand-piece with a contra-angle to enable one to reach positions difficult or impossible with a straight hand-piece. See Vol. II, Figure 303.

CONTRACTION. The act of becoming less in volume, all portions of the body shrinking equally in all parts in proportion to their dimensions.

CONVENIENCE FORM. In cavity preparation: Such special form as may be given to special points of the internal parts of cavities as will render the placing of the filling more convenient.

CONVENIENCE POINT. See starting point.

CORROSION OF THE ENAMEL. A term applied to the grosser manifestations of mottled enamel in which there is actual damage to the continuity of the tooth surface.

CORRUGATE. *a.* Contracted into ridges and furrows. A corrugated tooth is one the ordinary smooth surface of the enamel of which is ridged and furrowed.

CREVICE. A narrow opening resulting from the separation of a junction. See Gingival crevice.

CRISTOBALITE. One of the allotropic forms of quartz.

CROWN. That portion of a tooth which is covered with enamel, and which projects from the tissues in which the root is fixed.

CRUCIAL INCISION. An incision in the form of a cross.

CRUCIBLE. A container, either a part of the casting machine or formed in the investment within the flask, in which the gold is melted preparatory to casting; a pot made of refractory material, in which a material may be melted, sintered, calcined, or ignited.

CRUSHING STRENGTH (compressive strength). The greatest unit stress a body can sustain without rupture.

CRYSTAL. Form which a crystalline body assumes upon solidifying.

CRYSTALLINE. Having regularity or symmetry in the configuration of the atoms or molecules of which a material is composed.

CUNEIFORM. Wedge-shaped; applied to the characters of ancient inscriptions of Persia, Assyria, etc., generally made with a stylus, or point, in soft clay, which was afterward sun dried or baked; a cuneiform tablet.

CURLED ENAMEL. Enamel in which the enamel rods are much crooked and curled or intertwined with each other. See Vol. II, Figure 306B.

CUSP. A pronounced elevation, or point, on the surface of a tooth, more especially on the occlusal surface.

CUTTING EDGE. The edge formed by the junction of the labial and lingual surfaces of the incisor and cuspid teeth. In the cuspids, the edge is raised to a point near its center. The edge of excavators, such as hatchets, hoes, etc.; or of other cutting instruments.

CYST. An encapsulated cavity containing a fluid, which is secreted by epithelial cells which form the lining of the wall of the cyst.

DECAY. Latin, *Cadere*, to fall. To decline, to fall, to become less; to pass gradually from a sound, prosperous or perfect state to one of imperfection, adversity or dissolution. To waste away, to decline, to fall, to become weak, corrupt or disintegrated; to rot; to perish; as, a tree decays; fortunes decay; hopes decay.—Webster. Any wasting, disintegration, softening or deterioration by decomposition. Decay of the teeth is widely used as synonymous with caries of the teeth.

DECIDUOUS. That which will be shed. Deciduous teeth are those that are shed at periodical stages of growth of the person or animal. Applied to the teeth of childhood. They are also called temporary teeth.

DEFORMATION. Any change in shape of a structure, generally caused by an external force or load; a strain (*cf.* *Elastic deformation*); A deformation which disappears when the load is removed. *Permanent deformation*; A deformation which is permanent, after removing the load.

DEFORMITY. Misbuilding of any organ or part by which it is imperfectly formed; out of correct form.

DENDRITE. A tree-like crystal formation. Dendritic, adj.

DENSITY. Mass per unit volume.

DENTAL. Pertaining to the teeth.

DENTAL CARIES. A local disease of the teeth, in which the enamel is dissolved by the action of lactic acid as a waste product of microorganisms and the dentin is disintegrated by the vital activity of acid producing organisms penetrating the dentinal tubules. See Caries.

DENTAL NOMENCLATURE. The particular system of nomenclature used in dentistry. In many respects it is different from the nomenclature of comparative dental anatomy.

DENTIGEROUS. Containing or producing teeth, as a dentigerous cyst or tumor.

DENTIN. The tissue of which the main body of a tooth is formed.

DENTINAL FIBRILS. The living fibers filling the dentinal tubules. See Fibrils of Tomes.

DENTIN WALL. That portion of the wall of a cavity that is composed of dentin. See Vol. II, Figure 280.

DENTITION, THE. The teeth of the person or animal as a whole. The dentition of the monkey is very similar to that of the man.

DENTO-CEMENTAL JUNCTION. The line of junction of dentin and cementum.

DENTO-ENAMEL JUNCTION. The line of junction of the dentin and enamel. See Vol. II, Figure 280.

DESTRUCTIVE MOMENT OF FORCE. This term is applied to the condition in which the magnitude and angle of application of the pressure contact of certain teeth are such as to cause a pressure pericementitis.

DEVELOPMENTAL GROOVES. Fine depressed lines in the enamel of a tooth which mark the junction of its lobes.

DEVELOPMENTAL LINES. The lines of junction of the lobes of the enamel in its development. These lines may or may not be depressed.

DIAGNOSIS. The determination of the nature of disease.

DIASTEMA. A cleft or space, an abnormal opening in any part, as an interval between two teeth, which does not occur normally in man.

DIATHESIS. A particular habit or disposition of body. A certain natural constitution of body, cells and fluids, by which a person is predisposed to certain particular diseases; as the Hemorrhagic diathesis, a tendency toward profuse bleeding from slight cause; Gouty diathesis, a predisposition toward gout, etc.

DIFFERENTIAL DIAGNOSIS. The distinguishing between two similar diseases by comparison of their symptoms.

DISTAL. Away from the median line of the face following the curve of the dental arch. The surfaces of the teeth most distant from the median line are called distal surfaces.

DISTALLY. A direction away from the median line of the face following the curve of the dental arch.

DISTORTION. A change in volume, which is not uniform throughout a structure; a localized shrinkage or expansion affecting the general shape of a body.

DUCTILITY. Property by virtue of which a substance may be drawn out in tension without rupture.

DYSTROPHY. *Dys*—imperfect, defective, bad; *trophy*—growth. The condition resulting from defective formation or growth. Defective or perverted nutrition.

ELASTIC DEFORMATION. See deformation.

ELASTICITY. Capability of a deformed body to recover its size and shape after deformation.

ELASTIC LIMIT. The greatest unit stress a body can sustain and recover its original size and shape after the stress has been released.

ELONGATION. The amount a structure is elongated after rupture in tension, expressed in per cent of elongation after rupture in comparison with the original length; a measure of ductility.

EMBOLISM. A condition resulting from the obstruction of a blood vessel by a clot, or embolus, which has been carried by the blood from another part of the body.

EMBRASURE. The open space on either side of the contact point, to the occlusal (or incisal) of the septal tissue. These are called the buccal (or labial), and the lingual embrasures. It is through these that food, crushed between the teeth and divided by the contact points, glides upon the sloping surfaces of the septal gingivae to either side of the arch.

ENAMEL. The tissue covering the dentin of the crown portion of the tooth.

ENAMEL, CURLED. See Curled enamel.

ENAMEL MARGIN. The junction of a wall of a cavity with the surface of the tooth. It is continuous, forming the outline of the cavity. See Cavo-surface angle, and Outline form.

ENAMEL RODS. The form elements of which the enamel is made up. They are in the form of minute rods of extremely hard calcific material. These are cemented together in a solid mass by an intervening cement substance that leaves no openings. The general course of the enamel rods is from the dento-enamel junction to the surface of the tooth. On all parts the ends of the enamel rods are presented to the surface of the tooth.

ENAMEL RODS, INCLINATION OF. Used in describing either normal or abnormal inclination of the enamel rods from a direction perpendicular to the surface of the tooth.

ENAMEL, STRAIGHT. See Straight enamel

ENAMEL WALL. That portion of the wall of a cavity which is composed of enamel. See Vol. II, Figure 280.

ENDEMIC. *a.* Peculiar to or prevailing in some particular district or region. An endemic disease is one which is local; which is neither sporadic nor epidemic.

ENDURANCE LIMIT. The highest unit stress to which a material can be subjected under conditions of repeated application and removal of load an indefinite number of times, without failure of the material.

ENZYME. Any digestive body, or digestive fluid, such as pepsin, trypsin, ptyalin, pancreatin, etc.

EPULIS. A tumor upon the gum.

EQUITABLE DISTRIBUTION OF MASTICATORY FORCE. This term is applied to the condition of normal occlusion under which there is a just and equitable distribution of pressures and stresses on the periodontal membranes of all of the teeth in the various functional ranges of the mandible. *Maxwell.*

EROSION. A defect in a surface of a tooth characterized by a progressive loss of substance, leaving a polished or smooth surface which can not be accounted for by abrasion.

ESTHETIC. Pertaining to the science of esthetics, which treats of the pleasing and beautiful.

ETIOLOGY. The science of the causes of disease. This includes predisposing and exciting causes, remote and near, general and local, hereditary and immediate, or acquired.

EUTECTIC. An intimate mixture of two or more metals or alloys in the form of an alloy; an alloy whose constituents are insoluble in each other in the solid state, but soluble when molten; an alloy of specific composition such that it freezes as an intimate mixture at a constant temperature, and is the lowest freezing alloy as regards temperature of an entire series of alloys of the same components in varying proportions.

EXFOLIATION. The shedding of necrotic bone or dead epidermis.

EXTENSION FOR PREVENTION. Extension for the prevention of the recurrence of decay after a restoration has been made. In the preparation of pit and fissure cavities, the extension is along the line of each fissure to a point where the surface of the enamel is so smoothly rounded that the restoration may have a good margin. In the preparation of proximal and gingival third cavities, the extension is toward the axial line angles of the tooth for the reason that the regions of these angles are the least liable to the beginnings of caries of any portion of the circumference of the tooth near the margins of the gingivæ. For these cavities, the extension is also in the gingival direction sufficiently to place the gingival margin of the cavity in such position that it will be covered by the healthy gingiva.

FACET. On the teeth; a worn spot made by the rubbing of the proximal surfaces of adjoining teeth. A slight loss of the substance of the enamel in the beginning of erosion, etc. A facet may also be made by grinding with a fine stone. Facets occur on the occlusal surfaces of the teeth from wear.

FATIGUE. A gradual or progressive breaking of a material by repeating or alternating stresses, any one of which is not great enough to cause rupture.

FERMENT. A substance which causes chemical and physical changes in fermentable substances with which it comes in contact. Certain soluble ferments, as pepsin, pancreatin, ptyalin, etc., induce an action similar or identical with digestion; but do not induce further changes. The living ferments, microorganisms, carry the process to its ultimate ends by converting the fermentable substances into other chemical compounds.

FERMENTATION. Chemical and physical changes induced by certain microorganisms. A form of decomposition. There are a number of distinct fermentations, as vinous fermentation, lactic fermentation, acetic fermentation, etc.

FESTOON. An enlargement of that part of the interproximal gingivæ occupying the embrasures at the angles of the teeth buccally and lingually, but more commonly only the buccal portion.

FIBRILS OF TOMES. The prolongations from the odontoblasts which occupy the dentinal canals. They reach from the pulp chamber to the enamel or cementum. See Dentinal fibrils.

FILLING. *n.* The material placed in a prepared cavity in a tooth; the resultant of the act of placing a filling. *Syns.:* A restoration; a stopping.

FILLING. *v.* The act of placing filling materials into a prepared cavity of the tooth or roots of teeth. *Syns.:* Restoration; stopping.

FINGER POSITIONS. The positions of the fingers in performing dental operations. A systematization of the nomenclature of finger positions. See Vol. II, Figures 527-542.

FISSURE. A fault in the surface of a tooth caused by the imperfect joining of the enamel of the different lobes. Fissures occur along the lines of the developmental grooves, and more rarely along the lines of supplemental grooves.

FISSURE CAVITY. A cavity beginning along the line of a fissure.

FISTULA. [L] A reed, or pipe. An abnormal opening from a normal cavity to the surface for the discharge of a normal secretion. See Sinus.

FLEXIBILITY. Amount of deformation of a given character which a structure undergoes when a load is applied to it within the elastic limit.

FOCAL INFECTION. A term applied to the condition in which a primary focus of infection may cause a secondary manifestation of disease elsewhere in the body.

FOCUS OF INFECTION. A circumscribed region of tissue infected with pathogenic microorganisms.

FORCE. Any push or pull upon matter, either external or internal.

FORCE RESULTANT IN MASTICATION. The direction of movement of a tooth as a result of the moment of force applied by the tooth or teeth of the opposite arch.

FORMULA NAMES. A system of naming dental instruments based on the measurement of their working parts. See Volume II, page 88.

FOSSA. (Pl. Fossæ.) A round, or angular depression in the surface of a tooth. Fossæ occur mostly in the occlusal surfaces of the molars, and in the lingual surfaces of the incisors.

FRIT. A semi-fused porcelainic composition.

FUNCTION. The normal and purposive action of an organ, tissue or part.

FUNCTIONAL RANGE. Movement within the physiological limit. Movement beyond the functional range may or may not cause inflammation of the tissues involved.

GEL. A solidified jelly-like colloid.

GELATINOID. Gelatin-like. Having the appearance of gelatin. Used in describing masses that have the general appearance of gelatin but which are not of the composition of true gelatin.

GELATINOID PLAQUES. Masses of microorganisms in zoöglea form, or inclosed in a gelatinoid substance and attached to the teeth.

GINGIVA. (Plural, Gingivæ.) That portion of the gum tissue which invests the gingival portion of the crown of the tooth.

GINGIVAL CREVICE. The space between the gingiva and the enamel of the tooth crown; or in cases in which the gingiva has receded, between the gingiva and the cementum. Crevice is defined as "a narrow opening resulting from the separation of a junction."

GINGIVAL CURVATURE. The deviation of the gingival margin from the horizontal in its course around the tooth. See cemental curvature.

GINGIVAL MARGIN. The margin of a cavity that is toward or next to the gingiva. The margin, crest or edge of the gingiva.

GINGIVAL REGION. That portion of the crown of a tooth to the incisal or occlusal of the cemental line, covered by the gingivæ. The subgingival space is the space between the crown of a tooth and the portion of the gingivæ which is not attached to the tooth. See Cemental Line.

GINGIVALLY. A direction from any part of the crown toward the gingiva.

GINGIVITIS. Inflammation of the gingivæ. See Ulitis. While the term gingivitis should be limited to inflammation of the soft tissues immediately about the teeth and covering the borders of the alveolar processes, the term ulitis includes the wider inflammations that include the roof of the mouth and other parts.

GLOBULIN. Any one of a class of albuminous proteids, insoluble in water or alcohol, but soluble in weak solutions of neutral salts.

GLUTINOID. Glutin-like. Any semisolid which resembles glutin, or is glutinous; sticky adhesive.

GNATHODYNAMOMETER. An instrument for measuring in pounds, kilograms, etc., the force exerted in closing the teeth. See Vol. I, Figure 14A.

GOLD FOIL. Thin sheets of gold for making restorations in prepared cavities in the teeth. The thickness is expressed in numbers 1, 2, 3, 4, etc. The numbers express the number of grains of gold in a sheet four inches square.

GOLD, NON-COHESIVE. Gold in the form of foil or crystals in which the welding property is obscured, usually by the condensation of some gaseous substance upon it, or a film of a salt from the union of two or more gases.

GOUTY DIATHESIS. A constitutional state predisposing one to gout, which is a metabolic disease, characterized by recurrent attacks of arthritis and by inflammation of fibrous structures elsewhere.

GRAIN. Unit metallic crystal; a crystal with an orderly atomic space lattice on the interior, but with an external shape determined by the proximity of other crystals, or grains, in the metal.

GRANULOMA. A collection of infiltrating cells in a network of connective tissue; the cell types include lymphocytes, plasma cells, young fibroblasts and epithelial cells.

GRASPS, INSTRUMENT. See Instrument grasps.

GROOVE. A long-shaped depression in the surface of a tooth.

GUMS. The harder fleshy covering of the bones of the mouth, particularly of the roof of the mouth and the alveolar processes. See Gingiva.

GUTTA-PERCHA. A product of the latex or exudate from a tree of the family *Sapotaceae*.

HARDNESS. Resistance of a material to permanent deformation by any external force.

HAVERSIAN BONE. Bone composed of Haversian systems.

HAVERSIAN CANAL. A canal which occupies the center of a Haversian system.

HAVERSIAN SYSTEM. A long, cylindrical region in bone, usually placed lengthwise of the long bones, composed of a central canal surrounded by a number of concentric rings or layers of bone corpuscles.

HEIGHT OF CONTOUR. The line encircling a tooth crown in the horizontal plane and passing through the surface points of greatest distance from the long axis of the tooth. On the proximal surfaces this line passes through the contact points. The visible outline of the tooth crown when viewed from the occlusal. *H. E. Friesell.*

HEMOSTATIC. A medicinal agent that checks or arrests the flow of blood.

HERBIVOROUS. Animals that feed on plants.

HOOKE'S LAW. In tension, the induced force or stress is always proportional to the strain or deformation in elastic deformation.

HORIZONTAL PLANE. A plane through any part of a tooth at right angles to its length. See Vol. II, Figure 281.

HORN OF THE PULP. A process of pulp tissue extending toward the cusp of a tooth.

HYGIENE. The science which treats of the preservation of the health.

HYGROSCOPIC EXPANSION. An increase in volume of an investment or other plaster material, when placed in water after it has started to set. Not a normal setting expansion (cf).

HYPERCEMENTOSIS. Excessive formation of the cementum of a tooth.

HYPEREMIA. An excess of blood in the blood vessels of a part. *Active hyperemia*, an excessive inflow of blood to a part. *Passive hyperemia*, diminished outflow of blood from a part; or a filling of the tissues of a part with blood because of some interference with the circulation of the blood through the part. These are also called *arterial hyperemia* and *venous hyperemia*.

HYPERESTHESIA. Abnormally increased sensitiveness to painful impressions.

HYPERSENSITIVE. Excessive sensibility to irritation, thermal, chemical or mechanical. **Hypersensitive pulp.** Hypersensitive dentin. See Hyposensitive.

HYPOESTHESIA. Diminished sensitiveness to impressions which usually excite pain.

HYPOPLASIA. Abnormally diminished growth of a part. A partial failure of development because of lack of the ordinary full and complete growth. See Atrophy.

HYPOSENSITIVENESS. Abnormally diminished pain from definite causes which excite pain.

HUTCHINSON TOOTH. An incisor tooth presenting a notch or defect in the central portion of the incisal edge, caused by atrophy.

IMMOBILE. The opposite of mobile. The features of the person present less than the usual flexibility of muscular motion in speaking, laughing, etc. See Mobile.

IMMUNITY. The state of being completely resistant against disease.

INCISAL MARGIN. That margin of a surface of an incisor or a cuspid tooth formed by the incisal surface or cutting edge; as the incisal margin of the labial surface of the central incisor; the cavo-surface angle of the incisal wall of a labial or lingual cavity, etc.

INCISAL SURFACE. The cutting edge of the incisors and cuspids are sometimes called incisal surfaces.

INCLINATION of a tooth: The deviation of the long axis of a tooth from its normal position.

INFILTRATION ANESTHESIA. Loss of sensation produced by injecting an anesthetic into the subcutaneous tissue.

INFLAMMATION. The condition of the tissues which is the result of irritation or infection and which is accompanied by pain, heat, redness, swelling and impaired function.

INITIAL SET. Pertains primarily to the hardening of gypsum products. It is the time measured from the start of mixing the material with water until it is hard enough to support the weight of a circular flat surface, one-twelfth inch in diameter, impressed on the surface of the material under a load of $\frac{1}{4}$ pound.

INLAY. A porcelain or metal restoration to be inserted in a previously prepared cavity in a tooth and retained by cement.

INSPISSATED. Thickened by the evaporation or absorption of a fluid; an increased thickness or diminished fluidity.

INSTRUMENTATION. All uses of instruments in dentistry are included under this term.

INSTRUMENT GRASPS. Definite ways of grasping instruments suited to their uses, such as the pen grasp, thrust grasp, etc.

INTERGLOBULAR SPACES. Spaces left without calcium salts during the development, or growth, of the dentin. Many of these appear as spaces between imperfectly fused globules.

INTERMETALLIC COMPOUND. An alloy in which the constituents have combined in stoichiometric proportions.

INTERPROXIMAL. Between adjoining surfaces. The space between adjoining teeth as they stand in the line of the arch.

INTERPROXIMAL SPACE. The space bounded by the proximal surfaces of adjoining teeth, by the planes of their buccal (or labial), occlusal (or incisal), and lingual surfaces, and by the crest of the septum of the alveolar process between them.

INVESTING TISSUES OF THE TEETH. The gingivæ, peridental membrane, cementum and alveolar process. These tissues support the teeth in performing their function in mastication.

INVESTMENT. A compounded mixture of plaster of Paris, silica, and other ingredients, which sets to a hard mass when mixed with water.

INWARD INCLINATION. In comparative dental anatomy, a tooth that is inclined lingually. In dentistry, lingual inclination should be used.

ISOMERIC. Having the same percentage composition, but different molecular configuration.

LABIAL. Pertaining to the lips. Toward the lips.

LABIAL INCLINATION. An inclination or leaning of a tooth labially.

LABIALLY. A direction toward the lips.

LABIAL SURFACE. The surface of a tooth next to the lips. The incisors and cuspids have labial surfaces.

LABIO-LINGUAL. From the lips toward the tongue; as the labio-lingual diameter of the central incisor.

LABIO-LINGUALLY. A direction from the lips toward the tongue.

LATERAL OCCLUSION. The relation of the upper to the lower teeth when the mandible is moved to the right or left, as in chewing.

LATERAL PERICEMENTAL ABSCESS, or LATERAL ABSCESS. An abscess occurring within the tissues at the side of a root, usually in the depth of pockets in cases of chronic suppurative pericementitis. The pulp of the tooth may be vital.

LIGATURE. Anything that binds. A cord or thread for tying blood vessels, or for tying around the teeth.

LINE ANGLES. Of the teeth: Those angles formed by the junction of two surfaces along a line; as the mesio-buccal angle, disto-buccal angle, etc. Of cavities: Those angles formed by the junction of two cavity walls along a line; as disto-buccal angle or axio-gingival angle.

LINE OF ACCRETION. The lines of accretion or of contemporaneous growth seen in the enamel of the teeth. They are also known as the lines of Retzius, the person who first described them. See Accretion.

LINGUAL. Next to, or toward the tongue; as lingual surface.

LINGUAL INCLINATION. Said of teeth when they are inclined toward the tongue, or of a cavity wall that inclines toward the tongue; anything inclined toward the tongue.

LINGUALLY. A direction toward the tongue.

LINGUAL SURFACE. A surface of a tooth next to the tongue. All of the teeth have lingual surfaces. In comparative dental anatomy these are called inner surfaces.

LINGUO-GINGIVAL FISSURE. A fissure occurring occasionally in the lingual surface of the upper incisors. It usually separates the lingual lobe from one of the marginal ridges and extends into the cementum.

LINGUO-GINGIVAL RIDGE. A ridge near the gum on the lingual surface of the incisors and cuspids. It is on the lingual lobe.

LIQUIDUS. A curve representing the temperatures at which alloys having the same components but different compositions, begin to freeze on cooling, or become completely liquid upon heating.

LOAD, *n.* An external force applied to a body.

LOAD, *v.* To apply an external force to a body.

LOBE. A division of a tooth formed from any one of the separate points of the beginning of calcification.

LYMPHATICS. The lymphatic system consists of spaces, vessels, nodes and glands, which convey lymph from all parts of the body and discharge it via the thoracic and right lymphatic ducts to the great veins near the heart. Lymph consists chiefly of blood plasma exuded from the blood capillaries. The movement of the lymph is from the periphery and is a route of metastatic movement of infection or disease from one part or organ to another, as indicated by the enlargement of the cervical lymphatic glands in some cases of infection about the teeth, or of the axillary glands in cancer of the breast.

LYSIS. The process of cell destruction by any specific antibody in the blood serum which dissolves tissue cells.

MALLEABILITY. Ability to become permanently deformed without rupture under pressure, as rolling, hammering, etc.

MALOCCLUSION. An occlusion of the teeth that is not in accordance with the usual anatomical rule, or form.

MALPOSED. Out of the correct or normal position.

MALPOSITION. Any wrong position; abnormal position.

MAMMELONS. The three rounded prominences seen on the cutting edges of the incisors when they first come through the gums.—Magitot.

MANUDYNAMOMETER. An instrument by which the force exerted by an instrument thrust may be measured. See Vol. II, Figure 524.

MARGINAL LINES, of a cavity. The lines of the cavity outline.

MARGINAL RIDGE. The ridges, or elevations of enamel on the margins of the occlusal surfaces of the bicuspid and molars, and on the mesial and distal margins of the lingual surface of the incisors and cuspids.

MASTICATE. *v.* To chew food. To reduce food to a pulp by trituration and mixing with solvents, as in chewing and in the insalivation of food in the mouth.

MASTICATION. *n.* The act of chewing; the trituration of the solid foodstuffs between the teeth, by which they are reduced to a pulpy mass. One of the functions of the teeth.

MATRIX. A mold in which anything is formed. A thin sheet of metal closely fastened on a tooth to form a fourth surrounding wall of a proximal cavity in a tooth.

MEDIAN LINE. The anterior-posterior perpendicular central line of the body.

MESIAL. Toward the median line. Those surfaces of the teeth which, as they stand in the arch, and following its curve, are toward the median line, are called mesial surfaces.

MESIAL INCLINATION. An inclination or leaning of a tooth mesially.

MESIALLY. A direction toward the median line following the curve of the arch formed by the teeth.

MESIO-DISTAL. From mesial to distal; as, the mesio-distal diameter of the lower first molar.

MESIO-DISTALLY. A direction from the mesial toward the distal following the curve of the dental arch.

MESIO-DISTAL PLANE. A contraction of axio-mesio-distal plane (*q. v.*).

MESIO-LINGUAL GROOVE. A developmental groove running from the mesial surface diagonally to the lingual surface in upper first molars that have the fifth cusp.

METABOLISM. The sum of the nutritive processes in cells and organs of living things. It includes the vital phenomena of absorption, assimilation and nutrition on the one hand and the biochemical changes in the liberation of waste products on the other.

METAL. A material which may be classified typically as being fusible, opaque, a good electrical and thermal conductor, having a metallic lustre and electro-positive when in solution in the form of its salt.

METALLOGRAPHY. The science of metals and metal working.

METALLURGY. The science of extracting metals from their ores, and refining them for use.

MOBILE. Having wide movements, as mobile features, mobile lips, etc. The features of a person may be very mobile so that the teeth come prominently into view in laughing and speaking. This does not mean prominent teeth. See *Immobile*.

MODEL. A positive, or duplicate, of the mouth structures, or some portion of them.

MODULUS OF ELASTICITY. The constant of proportionality between tensile stress and accompanying tensile strain in elastic deformation, often called "Young's modulus." The term is occasionally applied similarly to elastic compression and shear also.

MODULUS OF RIGIDITY. The constant of proportionality between shearing stress and accompanying shearing strain in elastic deformation.

MODULUS OF RESILIENCE. The amount of energy stored up in a unit volume of material when it is deformed to its elastic limit.

MOLD. A matrix or cavity into which molten metal is cast.

MOMENT OF FORCE. Tendency to produce movement in a certain direction as a result of the magnitude of a force and the angle of its application.

MOTTLED TEETH. Marked with spots of different color or shades of color, blotched, variegated.

MUCIN. An albuminoid substance, the chief constituent of mucus. It is insoluble in water and is precipitated by alcohol, alum and acids. Mucin is present in saliva, mucous secretions, the bile, and in certain cysts.

MUCUS. A thick viscid secretion from the mucous follicles situated in the mucous membranes of the mouth. A somewhat similar mucus is found on other mucous membranes.

NAYSMITH'S MEMBRANE. A membrane-like glaze covering the enamel of a tooth, discovered by Naysmith. It may be parted from the enamel by careful digestion in weak solutions of acids. It is worn away from the parts of the teeth exposed to friction very early in life.

NECK. That portion of the tooth which forms the junction of the crown and root. This term has been loosely applied. See *cemento-enamel junction* and *cemental line*.

NECROSIS. Local death of a part of a tissue, especially of bone, in a mass.

NECROTIC. Pertaining to necrosis or local death of tissue, particularly of bone.

NERVE. "Nerve of a tooth." Once a common name for the dental pulp. *Obsolete.*

NEURITIS. Inflammation of a nerve, or of nerves.

NEUROSIS. A functional disease of the nerves.

NIB. That part of a working end of a plugger point that corresponds to the blade of an excavator.

NOMENCLATURE. A system of naming things or acts. Each profession or business has its own system of naming things or acts pertaining to it.

NIDUS. A nest or breeding place; the place where the germs of a disease or other organisms effect a lodgment or are developed.

NON-COHESIVE GOLD. Gold in the form of foil or crystals in which the welding property is obscured, usually by the condensation of some gaseous substance upon it, or a film of a salt from the union of two or more gases.

NON-CONDUCTOR. A substance which offers much resistance to the passage of any form of energy, as heat or electricity. The term applied to a non-conductive substance placed in a thin layer over the wall of a cavity nearest the pulp, to protect the pulp against thermal shock.

NUTRITION. The function of developing and renewing tissue and body processes by the absorption and assimilation of new materials utilized as food.

OBLIQUE RIDGE. A ridge running obliquely across the occlusal surface of the upper molars. It is formed by the union of the triangular ridge of the disto-buccal cusp with the distal portion of the ridge forming the mesio-lingual cusp.

OBTUNDANT. An agent or remedy which lessens or relieves sensitiveness to pain.

OCCLUDE. To shut; to close.

OCCLUDE. *v.* To absorb gases.

OCCUSAL SURFACE. *n.* That surface of a bicuspid or molar tooth that makes contact with a tooth of the opposite jaw when the mouth is closed.

OCCUSION. Absorption of gases by metals. The act of closing or shutting the teeth. Normal occlusion; the normal contact of the teeth of the lower jaw with those of the upper when the mouth is closed.

ODONTOBLASTS. A layer of oblong cells that line the pulp chambers of the teeth. They are the dentin forming cells. Processes from the odontoblasts pass through the dentinal canals to the dento-enamel junction, and to the junction of the dentin and cementum. See Fibrils of Tomes.

ODONTOCLASTS. The cells which are the active agents in the resorption of the roots of the temporary teeth.

OMNIVOROUS. Animals that eat all kinds of food indiscriminately.

"ONE-TWO-THREE." "1-2-3." A local antiseptic composed of oil of cassia, 1 part, phenol (melted crystals), 2 parts, and oil of wintergreen, 3 parts. The oils should be mixed and the melted crystals of phenol should be added.

ONTOGENETIC. The development or evolution of an individual organism, as a man or an animal of any species. This term is used in relation to phylogenetic, which is applied to the development or evolution of a group or species of animals or plants.

ORAL. Pertaining to the mouth, as Oral Surgery.

ORTHODONTIA. The moving of malposed teeth to correct positions. The art of regulating the position of malposed teeth.

OSTEITIS. Inflammation of bone.

OSTEOBLASTS. The cells which form bone.

OSTEOCLASTS. The giant cells which effect the resorption of bone.

OSTEOMYELITIS. Inflammation of the bone marrow.

OUTLINE FORM. In cavity preparation; the form of the area of tooth surface included in the prepared cavity.

OUTWARD INCLINATION. Said of cavity walls when they diverge from each other in approaching the surface of the tooth.

PALM-AND-THUMB GRASP. The instrument shaft is grasped in the palm of the hand and the working point brought into opposition to the thumb as a counteracting force. Used in positions in which an instrument can be applied to one side or portion of a tooth, or other object, while the thumb of the same hand is rested upon it, or upon adjacent teeth. See Vol. II, Figure 523.

PEN GRASP. A grasp of dental instruments closely resembling the usual grasp of a pen used in writing. In the use of dental instruments the pulps of the thumb, first and second fingers should be on the instrument shaft. See Vol. II, Figure 520.

PERIAPICAL. This term is applied to the tissues adjacent to the apical portion of the root of a tooth, which include those involved in infections resulting from the death of the dental pulp.

PERIAPICAL ABSCESS. An abscess occurring within the tissues about the apex of the root, as a sequella of the death of the dental pulp.

PERIAPICAL CYST. A cyst occurring about the apex of a root, usually as a sequella to the death of the pulp.

PERICEMENTITIS. Inflammation of the tissues adjacent to the cementum. *Note:* In this work, either the word apical or periapical is used with pericementitis or some other term, to designate inflammations involving the periapical tissues, as chronic apical pericementitis, chronic periapical abscess, periapical cyst, etc., while the word pericementitis is used to designate inflammations beginning in the gingival region and involving the tissues adjacent to the sides of the root, as pressure pericementitis and chronic suppurative pericementitis.

PERICEMENTUM. The membrane covering the cementum of the roots of teeth. See Peridental Membrane.

PERIDENTAL MEMBRANE. The membrane surrounding the root of a tooth and forming its attachment to the walls of its alveolus. It is composed of fibers which are built into the cementum on the one side and into the bone on the other. Among these fibers there is an abundant network of blood vessels, nerves and cellular elements.

PERIOSTEAL BONE. Bone laid down by the osteoblasts of the periosteum as distinguished from Haversian system bone.

PERIOSTITIS. Inflammation of the bone and the periosteum.

PERMANENT TEETH. The teeth of adult age as distinguished from the temporary, or deciduous teeth.

PERMANENT TEETH, CHILDHOOD PERIOD OF. The period from the first appearance of the permanent teeth until their roots are fully completed, except the third molars. See Vol. I, Figure 12, and Vol. III, page 113.

pH. Hydrogen ion exponent; a convenient method for indicating hydrogen ion concentration values. $\text{pH}=7$ is neutral. Any value less than seven is progressively more acid; values 8-14 inc. are progressively more alkaline.

PHAGODYNAMOMETER. An instrument by which the force required in crushing different examples of foodstuffs is determined. See Vol. I, Figure 14B.

PHASE. A homogeneous, physically distinct portion of matter in a non-homogeneous system.

PHYLOGENETIC. The development or evolution of a group or species of animals or plants. This term is used in relation to ontogenetic, which applies to the development of an individual organism, as a man or an animal of any species.

PIT. A sharp, pointed depression in the enamel. Pits occur mostly where several developmental grooves join; as in the occlusal surfaces of the molars, at the endings of the buccal grooves on the buccal surfaces of the molars; occasionally in the lingual surfaces of the incisors.

PLANES of the teeth. Any planes cutting the teeth in definite directions, as the axial plane, horizontal plane, etc.

PLASTER OF PARIS. A hemihydrate of gypsum, having the chemical formula of $(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$.

PLASTICITY. The property of sustaining permanent deformation without rupture.

PLASTICS. Materials like cements, gutta-percha and amalgam for filling cavities in teeth; a material for any purpose that may be easily modeled and built into form.

PLUGGER. An instrument for condensing gold or other material in cavities in teeth. See condenser, which is the preferred term.

POINT OF PROXIMAL CONTACT. The point at which the proximal surface of a tooth touches the proximal surface of a neighboring tooth. See Contact Point.

PORCELAIN (dental). A vitreous, hard, vesicular, translucent material, usually having a glazed surface, which consists of solid particles of aggregate united by a glassy bond.

POSITIONS AT THE CHAIR. Those positions which the dentist should assume in doing dental operations. A systematized nomenclature of positions at the chair. See Vol. II, Figures 506 to 515.

PREPARATION OF CAVITIES. Those operations required in forming cavities in teeth for the reception of restorations.

PRESSURE ANESTHESIA. Loss of sensation resulting from the application of an anesthetic with sufficient pressure to force it into the tissue, as into the dentinal tubules, or through the tubules into the dental pulp.

PRESSURE CONTACT OF THE TEETH. The condition when the upper and lower teeth are in occlusion in any position, and the muscles of mastication are contracted, causing the lower teeth to press against the upper teeth.

PRESSURE SIDE, OR REGION. A term applied to that side of the root of a tooth, or to that region adjacent to any portion of the root, on which the peridental membrane is compressed by pressure exerted on the crown of the tooth in a particular direction. See Traction side.

PRESSURE PERICEMENTITIS. Inflammation of the pericemental structures resulting from a lack of balance between the masticating force and its direction on the one hand and the resistance of the supporting structures on the other.

PREVENTION. Art of preventing or hindering.

PREVENTIVE TREATMENT. Treatment to prevent disease, particularly in an individual, as a result of a recognized tendency or danger.

PRIMARY FOCUS OF INFECTION. The original site of infection, which may result in a secondary manifestation of disease elsewhere in the body.

PROGNATHISM. Abnormal protrusion of one or both jaws.

PROGNOSIS. A prediction as to the progress and result of a disease.

PROPHYLACTIC. Tending to prevent disease; guarding against disease. A medicine or preparation which defends or protects against disease. Something applied to healthy tissue to prevent disease.

PROPHYLAXIS. Preventive medicine. Oral prophylaxis: Preventive measures against diseases of the mouth.

PROPORTIONAL LIMIT. The greatest unit stress which may be induced in a structure such that the unit stress is proportional to the accompanying unit strain.

PROTRUSION. To thrust forward, as the protrusive movement of the mandible in biting.

PROXIMAL. Latin; proximus, near; propior, nearer; propious, next or nearest. That surface of a tooth that is toward, nearest, or in contact with another tooth to the mesial or distal as the teeth are arranged in the arch.

PROXIMAL CAVITIES. Cavities beginning in the proximal surfaces of the teeth. As both mesial and distal cavities are included under this term, it is used only when it is intended to include mesial and distal cavities collectively, or when the position, mesial or distal, is not determined, or mentioned; as proximal cavities in the incisors.

PROXIMAL CONTACT. The contact, or touching, of the proximal surfaces of neighboring teeth.

PROXIMAL SURFACE. The surface of a tooth which lies next to another tooth, to the mesial or to the distal.

PROXIMATING. A tooth or portion of the surface of a tooth making near approach to another tooth or portion of the surface of another tooth.

PULP. The soft tissue that fills the pulp chambers and root canals of the teeth. It is the formative organ of the dentin.

PULP CANAL. The central opening lengthwise in the root of a tooth leading from the pulp chamber or bulb of the pulp in the crown portion of a tooth to the apical end of the root. Syn. Root Canal.

PULP CHAMBER. The central opening in the dentin of the crown portion of a tooth which is occupied by the pulp of the tooth. In the double and triple-rooted teeth, the pulp chambers are very distinct from the root canals, but in teeth having but one root the pulp chamber is not distinctly divided from the root canal.

PULPITIS. Inflammation of the dental pulp.

PUTREFACTION. Putrefactive fermentation. Decomposition with a foul odor of animal or vegetable matter, effected by the action of microorganisms. The true putrefactions occur only when oxygen is excluded, but decompositions of a somewhat similar nature occur in the presence of oxygen.

PUTRESCENT. A state of decomposition with emission of foul odor.

PYOGENIC. Said of a microorganism that generates pus, or causes pus formation. The staphylococcus albus, staphylococcus aureus, streptococcus longus, etc., are pus-generating microorganisms. They are therefore pyogenic.

PYORRHEA. A flow of pus. *Pyorrhea alveolaris*; a flow of pus from the alveoli of the teeth.

QUADRANGLE. In instrument nomenclature designates an instrument with four angles or curves in the shank.

QUARTZ. A mineralogical form of silica.

RADICULAR CYST. See Periapical cyst.

RECRYSTALLIZATION. The operation of annealing; a rearrangement in grain structure brought about by heat. Recrystallization temperature. Annealing temperature.

REDUCTION IN AREA. A measure of ductility, determined by expressing the ratio of the decrease in cross section area at the point of rupture under tension to the original cross section area, in per cent.

RESECTION. To cut off; to remove a part of, as to cut off the end of a root, or a portion of the gum.

RESILIENCE. The energy stored up in a structure when elastically deformed.

RESISTANCE FORM. In cavity preparation; the shape given to the internal parts of a cavity to afford such a seat for the restoration as will best enable it to withstand great stress without movement.

RESORPTION. The removal of an exudate, a blood clot or of tissue by absorption; a loss of substance by lysis, as the resorption of the roots of the temporary teeth. See Absorption.

RESTORATION. The material placed in a prepared cavity in a tooth. Syns. A filling; a stopping.

RETARDER. Anything which decreases the speed of a chemical or physical reaction; opposite of accelerator (cf).

RETENTION FORM. In cavity preparation; the form of the internal parts of a cavity provided to prevent the displacement of the restoration by force.

RETZIUS, CALCIFICATION LINES OF. See Lines of Accretion.

RIDGE. A long-shaped elevation on the surface of a tooth.

ROOT. That portion of the tooth that is fixed in the alveolus, or socket, and is covered with cementum.

ROOT CANAL. The opening through the center of the long axis of the root of a tooth from the crown to the apex, which under normal conditions contains the root portion of the dental pulp. Syn. Pulp Canal.

ROOT CYST. See Periapical cyst.

ROPY SALIVA. Saliva that may be drawn out in threads by touching it with the finger and pulling away. See Viscous Saliva.

ROUND CELLED INFILTRATION. Permeation of the tissues with round cells.

RUBBER DAM. A thin sheet of very elastic rubber used for keeping the teeth, and especially cavities in the teeth, dry and clean while performing such operations as filling, removing pulps, filling pulp canals, etc.

RUBBER DAM CLAMP. An instrument made to set on a tooth to hold the rubber dam in place.

RUBBER DAM GRASPS. The forms of grasp of the rubber dam best suited to its application to teeth in different parts of the mouth. Of these there are five, numbered first, second, etc. See Vol. II, Figures 555 to 572.

RUGAE. A series of irregular ridges in the roof of the mouth.

SALIVA. The fluid poured into the mouth from the salivary glands. Usually when the saliva is spoken of without restricted definition, the mixed fluid as found in the mouth is meant. It is composed of the saliva proper from the parotid, submaxillary, sublingual and other smaller glands, and the secretion of the mucous follicles, which open into the mouth.

SCALER. An instrument designed to be used in removing deposits, particularly calculus, from the teeth.

SCALING. The removal by special instruments of scale-like deposits of calculus from the crowns and roots of the teeth. A curetting process.

SECONDARY FOCUS OF INFECTION. An infection occurring in any part of the body which results from a primary or original focus.

SENILE. Pertaining to old age.

SEPARATOR. An instrument or mechanical appliance designed for forcibly separating teeth for obtaining space between proximal surfaces for examinations, excavation of cavities, finishing restorations, etc.

SEPSIS. Poisoning produced by the absorption of putrefactive products.

SEPTAL GINGIVA. That portion of the gingivae in the interproximal space.

SEPTAL SPACE. That portion of the interproximal space normally filled by the interproximal gum septum, or the septal tissue.

SEPTUM. (pl. Septa.) A partition; that portion of the alveolar process which lies between the roots of the teeth separating their alveoli.

SEQUELLA. (pl., Sequellæ). A morbid condition which follows as a result of another disease.

SEQUESTRUM. A mass of necrosed bone which has been separated from the surrounding healthy bone.

SERUMAL. Pertaining to the serum of the blood. Derived from serum. Serumal calculus: Calculus on the roots of teeth derived from the blood.

SETTING EXPANSION. An increase in volume of a material, occurring during its set. Pertaining to dental investments: *Free setting expansion.* The unimpeded increase in volume which occurs during set, caused by an allotropic change in crystalline form. *Effective setting expansion.* That portion of the free setting expansion which is effective as shrinkage compensation in a casting technic.

SHEARING STRENGTH. The greatest unit of shearing stress which a structure sustains before or at rupture.

SHEARING STRESS. A force induced within a body by a load such that the induced force resists a deformation which tends to cause one portion of the body to slide over another portion; resistance to a twisting deformation.

SHOCK. A sudden, severe depression of vital functions, particularly as affecting the nervous and circulatory systems.

SILICA. A chemical compound of silicon; silicon dioxide (SiO_2).

SMOOTH-SURFACE CAVITY. A cavity formed by caries beginning in any smooth surface of a tooth, or portion of a surface free from pits or fissures. The term is confined to cavities beginning in the axial surfaces of the teeth.

SOLID SOLUTION. An alloy the components of which are soluble in one another, both in the liquid and solid states.

SOLIDUS. A curve representing the temperature at which alloys having the same components, but different compositions, begin to melt upon heating, or become completely solid upon cooling.

SPACE LATTICE. Foundation of crystal form; a series of points in space such that every point is situated similarly to every other point.

SPECIFIC GRAVITY. Ratio of the mass of a body to that of an equal volume of water. It is numerically equal to density, if the latter is expressed in metric units.

SPORADIC. *a.* Occurring here and there, or at irregular intervals; not widely diffused; not epidemic.

SPRUE. Ingate through which the metal pours into the mold.

SPRUE BASE. The base to which the sprue former is attached for convenience in investing, and in most cases it also acts as a crucible former (*cf.*).

SPRUE FORMER. **SPRUE PIN.** A piece of wood or metal used by a molder in casting metals, to form the ingate for the molten metal; used to form the passage or ingate for making an inlay of cast metal, gold, etc.

STARTING POINT. A small depression or undercut to make the anchorage of the first several pieces of gold more convenient, in placing a gold foil restoration. See Vol. II, Figure 300C.

STERILE. Not containing microorganisms; aseptic.

STERILIZATION. The process of freeing a substance from microorganisms and their spores.

STERILIZE. To thoroughly cleanse; to make an instrument, or the operator's hands, or the tissues aseptic. To remove absolutely or destroy the life of all microorganisms and their spores; to make the hands and instruments surgically clean.

STOICHIOMETRIC. Calculations of the quantities of chemical elements or compounds involved in chemical reactions.

STOMATITIS. Inflammation of the mucous membranes of the mouth.

STRAIGHT ENAMEL. Enamel in which the enamel rods lay parallel with each other and usually are straight from the dento-enamel junction to the surface of the enamel. See Vol. II, Figure 306A. See Curled Enamel.

STRAIN. *n.* Any sort of deformation. *Unit strain.* A deformation per unit dimension.

STRAIN. *v.* To deform.

STRAIN HARDENING. Hardening produced in a metal or alloy by cold working.

STRESS. Internal force within a body, induced by an external load; an internal force which tends to resist a strain. *Unit stress.* Stress per unit area.

STRESS. PRESSURE. In dentistry, the word stress is applied to the pressure of the surfaces of the upper teeth against the lower as the jaws are closed in mastication.

STRUCTURE. A definite arrangement of a material in a form adapted to the accomplishment of a purpose.

SUBPERIOSTEAL BONE. Bone lying under the periosteum. Bone formed from the periosteum as distinguished from Haversian systems bone.

SUCCEDANEOUS TEETH. The teeth which succeed to, or take the places of the deciduous teeth after the latter have been shed: The incisors, cuspids and bicuspid.

SUCCESSIONAL TEETH. Same as Succedaneous Teeth.

SULCATE GROOVE. A groove following the bottom of a sulcus.

SULCUS. (*Pl. Sulci.*) A notable long-shaped depression in the surface of a tooth, the inclines of which meet at an angle. A sulcus has a developmental groove at the junction of its inclines.

SUPPLEMENTAL GROOVE. A shallow long-shaped depression in the surface of a tooth, generally with a smoothly rounded bottom. Supplemental grooves differ from developmental grooves in that they do not mark the junction of lobes.

SUPPLEMENTAL LOBE. A lobe that does not belong to the typical form of the tooth; an additional lobe.

SUPPLEMENTAL RIDGE. A ridge on the surface of a tooth that does not belong to the typical form of the tooth; an additional ridge.

SUPPURATION. The act of pus formation. The formation of pus.

SURFACE TENSION. A molecular force existing in the surface film of all liquids measured as force per unit length.

SUSCEPTIBILITY. A condition of marked liability to infection or disease.

SYSTEMIC DISEASE. A general disease which affects the body as a whole.

TEMPORARY TEETH. The first set of teeth, which are shed and replaced by the successional teeth of the permanent dentition. See Deciduous Teeth.

TENSILE STRENGTH (ultimate strength, strength). The greatest unit tensile stress which can be induced in a structure before rupture.

TENSILE STRESS. The internal force induced within a body by a stretching load.

THE BITE. The power of force with which the teeth may be closed in the crushing of food, is called the strength of the bite, or simply, the bite. It is measured with the gnathodynamometer.

THICK-NECKED. A tooth in which the mesio-distal diameter of the neck is nearly equal to that of the crown. See Bell-crowned.

THROMBOSIS. The process by which a blood clot is formed within a blood vessel.

TINE. A tooth, a spike, as of a fork; a prong, as of an antler. (Webster.) A slender pointed instrument; as an exploring tine.

TOILET OF THE CAVITY. Consists in freeing the internal surfaces of the cavity from all chips or fine dust. The final cleaning of cavity walls before beginning a restoration.

TOPICAL ANESTHESIA. Loss of sensation produced by applying an anesthetic directly to the tissue, as to the dentin.

TOUGHNESS. The total energy or work expended in rupturing a material; opposite of brittleness (cf).

TOXIN. Any poisonous substance produced in nature by animal or vegetable cells or by bacteria.

TRACTION SIDE OR REGION. A term applied to that side of the root of a tooth, or to that region adjacent to any portion of the root, where the periodontal membrane is stretched as a result of pressure applied to the crown of the tooth in a particular direction. See Pressure side.

TRANSVERSE RIDGE. A ridge formed of two triangular ridges, which join to form a continuous ridge across the occlusal surface of a tooth.

TRIANGULAR RIDGE. A ridge running from the point of a cusp toward the central portion of the occlusal surface of a tooth.

TRIDYMIT. An allotropic form of quartz.

TUBERCLE. A slight rounded elevation on the surface of a tooth. Tubercles occur frequently on the linguo-gingival ridge of the incisors, and occasionally upon various parts of other teeth. They are deviations from the typical tooth forms.

TUBULES. (Pl. Tubuli.) The minute tubular canals which radiate from the pulp chamber and canals through the dentin to the dento-enamel junction in the crown and to the dento-cemental junction in the root of the tooth.

TUMEFACTION. The process by which a swelling is produced.

ULITIS. A general inflammation of the gums as distinguished from gingivitis, which is confined to the free margins of the gums and immediate neighborhood.

VICAT NEEDLE. Apparatus used to measure the initial setting time of gypsum products.

VISCOSITY. Resistance offered by a fluid to the relative motion of its particles; internal friction.

VISCOUS SALIVA. Saliva that is noticeably thick or gummy. Usually the saliva is a very thin, watery fluid, but some persons have saliva that has so large a proportion of mucus that it is thick and tenacious to a very noticeable degree. See Ropy Saliva.

VITAMIN. One of several basic substances which are required in small amounts for the adequate nutrition of the body. Fat-soluble vitam A is necessary for the growth and integrity of the epithelial linings of the mucous tracts and the epithelium of the skin; water-soluble B, is an antineuritic vitamin, which prevents beri-beri; water-soluble C, prevents scurvy; fat-soluble D prevents rickets; and vitamin E is the reproductive factor, deficiency of which causes sterility.

YIELD POINT. A quantity often determined in testing as a substitute for the elastic limit; a unit stress value for which an easily perceptible increase in length occurs for a slight increase in tensile load.

ZONES OF INJURY. Said particularly of the injuries of the teeth in hypoplasia. These injuries are spread in sheets or zones through certain parts of the enamel and dentin.

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