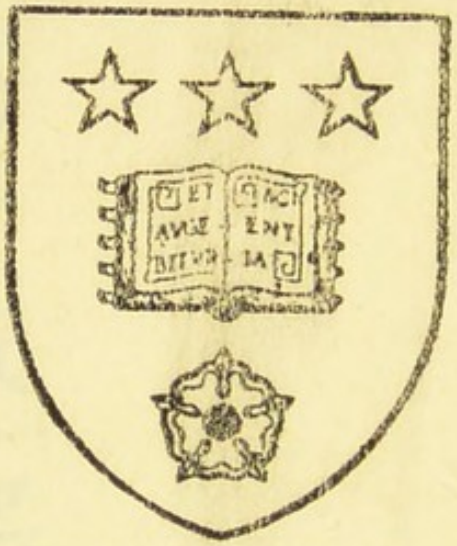
Extraction of teeth / F. Coleman.

EXTRACTION OF TEETH

COLEMAN

SECOND EDITION



L. H. Cartwright.

EXTRACTION OF TEETH

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BY

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ASSISTANT DENTAL SURGEON TO THE ROYAL DENTAL HOSPITAL

SECOND EDITION

WITH FIFTY-SEVEN ILLUSTRATIONS

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PREFACE

TO THE SECOND EDITION

The size of this book has not materially altered since its first publication, although the text has been largely re-written and many new illustrations incorporated.

This change has been effected by some rearrangement of the subchapters, the elimination of illustrations of instruments not in common use, and the substitution of others of more value. The few additional pages are chiefly accounted for by a fuller description of local anæsthesia.

General anæsthesia has only been mentioned in as far as it bears upon the subject under consideration.

For portions of the last chapter dealing with anæsthetics the author is under an obligation to Mr. Harvey Hilliard for permission to quote from their joint work on "Anæsthetics in Dental Surgery."

Other obligations gratefully acknowledged are those to Messrs. Claudius Ash for their usual courtesy and assistance in the publication of all books relating to Dental Surgery, and to the Photochromo Company for the execution of the new illustrations and drawings.

The revision of my proof-sheets was kindly undertaken by Mr. N. G. Bennett, and to him I offer my sincere thanks.

F. C.

May, 1914.

PREFACE

TO THE FIRST EDITION

In this small work I have endeavoured to treat a subject of interest both to the general and dental practitioner.

Although it is a worthy aim to treat teeth where possible by conservative measures, these measures may be persisted in to the detriment of the patients' health, and a distinct line must be recognized between the possibility of restoring to function a tooth or root and the advisability of so doing.

Teeth are more easily made comfortable to the patient than to his tissues, and a difficult point often arises in how far the latter and more stringent test is to be considered.

Disease in distant parts of the body has not infrequently been traced to teeth filled or crowned, and relieved by their removal. It is with the above points in view that I venture to bring this subject forward.

I have to express my obligation to Mr. Tomes and Mr. Colyer for some of the illustrations I have borrowed from their works, and to Messrs. Ash, and Smith, Elder and Co., for most of the remainder; my thanks are further due to the latter for the freedom they have allowed me in quoting from my father's "Manual of Dental Surgery."

Finally, I am indebted to Dr. Austen for his kindness in looking through my revised pages.

F. C.

June, 1908.

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CHAPTER I

TECHNIQUE OF EXTRACTION OF TEETH

General Principles of Extraction.

The operation of extraction is one which requires skill, judgment, and experience, as well as an accurate knowledge of the anatomy of the teeth and their surrounding parts.

Skill in the operation is only to be obtained by the training and development of a sense which may be described as partly tactile and partly muscular.

The operator who has acquired this sense loses that rapid and mechanical method of extraction witnessed in a beginner and accompanied so frequently by undesirable results, and becomes, perhaps, a slower, although a far more reliable, extractor. His sense of touch informs him of the character of the tooth to be extracted, and his sense of resistance of the amount of force to be used and the most advantageous direction in which to apply it.

The change of an instrument may be desirable for obtaining better adaptation to a tooth or for more efficiently carrying out the extractive movements, and this should be perceived by the feeling of resistance before undue strain is placed upon the tooth.

An unfortunate error has arisen in regarding the operation of extraction as being one that can be carried out

rapidly, although no doubt it frequently has to be hastened to curtail the pain inflicted during its progress; nevertheless, rapidity in itself is far from desirable.

Local anæsthesia and the continuous methods of administration of nitrous oxide have fortunately rendered rapid extraction less necessary; consequently the movements for loosening a tooth can be carried out more carefully with less injury to the alveolus, less risk of fracturing the tooth, and less after-pain.

The operator who accustoms himself to a rapid mechanical method of operating, regardless of the fact that no two teeth are alike, will never develop that specially trained sense without which safe extraction becomes impossible.

The extraction of a tooth should be regarded in the same light as any other operation in surgery, and the element of chance as to whether the operation be successful or otherwise should never be allowed to arise, even for the purpose of rapidity of procedure.

Further, the actual conditions present are often averse to hurried operating; thus the tooth may be frail and require the utmost care in selecting the firmest portion to which the instrument can be applied, or it may be too frail to withstand the ordinary closure of the forceps, in which case the blades of these must be used in the manner of a trephine, allowing the root to drop out almost by its own weight as soon as the bone around has been sufficiently trenched.

The removal of a frail tooth is comparable to the removal of a sequestrum of bone, and no surgeon would limit himself to a few seconds if he were desirous of carrying out this operation successfully.

Safe extraction can only be acquired by the development of a definite sense and the regulation of our movements in response to its guidance.

The transverse fracture of a tooth, except in the region

of its apex, where it may be so curved as to offer mechanical impossibilities to its complete removal, should be regarded as an almost invariably avoidable accident. Insufficient experience, imperfect technique, and undue haste, are the chief reasons why teeth are fractured.

The **indications for extraction** are mainly determined on three factors, which, stated in their order of importance, are as follows:

1. The *condition of the tissues.*
2. The *condition of the tooth.*
3. The *condition of the "bite."*

1. *The Condition of the Tissues.*

The tissues in the neighbourhood and those more distant may be influenced by the presence of diseased teeth, and extraction is often the only means of removing this source of irritation.

These conditions may be stated as follows:

1. Inflammation and suppuration arising from infection by a tooth which cannot apparently be relieved and certainly cannot be cured by drainage through the tooth or by a counter-opening elsewhere, and where delay in giving relief may result in extension of the infection or in other sequelæ.

2. The presence of ulceration, necrosis, and other pathological lesions in association with diseased teeth, or the mechanical irritation of such lesions by sound or diseased teeth, if the teeth in question are not readily amenable to treatment, or where it is desirable to remove all sources of irritation immediately and permanently.

3. Teeth causing hyperplasia of the lymph-glands, or acting as a source of irritation to pre-diseased lymphatic tissue—*e.g.*, tuberculous lymphadenitis, lymphadenoma, and malignant disease.

4. Trigeminal neuralgia, which has resisted all general and local measures short of operative treatment, and before the more serious operations of surgery are contemplated.

5. If the saving of a tooth would necessitate a long and tedious operation in a person of delicate health, or if the cause of ill-health be some irritable condition of the nervous system—*e.g.*, chorea—the movements of which may preclude conservative treatment.

6. As a preliminary to other larger operations—*e.g.*, excision of the maxilla or mandible, epithelioma involving the frænum of the tongue or its vicinity.

7. To allow feeding-space in some cases of permanent closure of the jaw—*e.g.*, ankylosis of the temporo-mandibular articulation and cicatrization of the tissues of the cheek.

2. *The Condition of the Tooth.*

Under this heading are summarized irregularities in the shape, position, and number of the teeth, their firmness, the extent of caries, injury, or periodontal disease.

These conditions may be stated as follows:

1. Malformed or malplaced teeth. These are frequently associated conditions, and the teeth may require extraction owing to the deformity produced or their liability to predispose to caries of the adjacent teeth.

2. Teeth erupted in abnormal positions, incapable of being brought into alignment, and interfering with the comfort of the tongue, lips, and cheek, or if their faulty position predisposes to caries in the adjoining teeth.

3. If the teeth be crowded to such an extent that their function is impaired.

4. Teeth which have become so loose from absorption or destruction of their alveoli as to be useless—indeed, impediments to mastication.

5. Teeth carious or injured to such an extent that it would be inadvisable to adopt conservative treatment.

6. Teeth causing chronic periodontitis, where local and general treatment has failed to give relief.

3. *The Condition of the "Bite."*

This factor may influence our decision as to the method of treatment to adopt when, for other reasons, the question of extraction is in the balance.

1. A tooth is rendered less efficient by the loss of its antagonist, or may, by its extrusion, prevent satisfactory occlusion being restored in those cases where artificial aid is required.

2. Where one or more teeth remaining in the jaws are, from their condition or position, unsuitable for retention when artificial substitutes are being considered.

Diagnosis of the Tooth at Fault.

The determination of the tooth or teeth at fault may present no difficulties, yet at times it may be beset with great difficulties, and require the most careful attention to the signs and symptoms that the patient presents for its elucidation.

There are certain characteristic features associated with pathological conditions of the teeth that are often of value as an additional aid in diagnosis. Thus—

A. The Character of the Pain.

1. The distinctive features of pulp and periodontal pain.

2. The fact that dental pain is almost invariably referred to the side of its origin.

3. The fact that dental pain is frequently referred to a

tooth situated more forward in the dental arch, and rarely to a tooth situated more posteriorly.

4. The direction in which pain is referred—*e.g.*, the ear from a lower back tooth.

B. The Character of the Inflammation and its Sequelæ.

1. Fulness of the sulcus is usually most marked in the region of the affected tooth, and frequently passes to the causative root in the form of a neck.

2. Abscess of the palate is frequently caused by a lateral incisor tooth.

3. Trismus is usually associated with a mandibular molar tooth, and frequently the third molar.

4. Teeth with short roots are more liable to cause intra-buccal than extra-buccal swelling. A deciduous tooth (except a second mandibular molar) is rarely the cause of suppuration tracking beneath the deep cervical fascia.

5. The track of a sinus due to a tooth rarely crosses a socket, so that the cause of a sinus is almost invariably the tooth to which it corresponds.

6. A sinus on a mucous surface may only be disclosed by rendering the tissues taut. Its presence is strong evidence of a foreign body.

C. The Site of a Lesion on the Movable Soft Parts.

The association of pathological conditions of the movable soft parts—*e.g.*, the tongue and cheeks—with the teeth can only be determined by observing the relation of these parts in their resting positions.

Some of the main indications for the extraction of teeth and their diagnosis having been stated, the following examination should be carried out when this operation has been decided upon:

A careful *examination of the tooth* to be removed should be made, noting especially the amount of sound tooth-substance present, its relation to surrounding structures, and the amount of force that will probably be necessary for its removal.

In the case of hollow teeth the amount of sound tissue present, and its density, must be gauged by means of a blunt probe, and if part of the tooth be carious below the gum, its margins must be defined. The most useful probe for this purpose is one with a blade nearly $\frac{3}{4}$ inch in length, flattened in the same plane as the handle, and nearly at a right angle to it, the instrument being made in one piece of metal (Fig. 1).

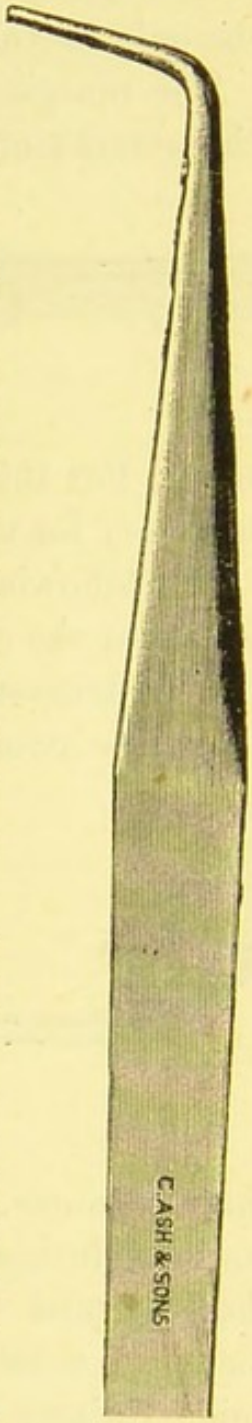


FIG. 1.—BLUNT PROBE (MOON).

Any resistance felt at the extremity of the instrument will be directly conveyed to the tip of the palmar surface of the first finger, the most responsive part of the hand to the sensation of touch.

A sharp-pointed probe is also useful for detecting interstitial or hidden caries and for determining the density of a hard substance in the gum, and likewise any mobility. A substance feeling dense and slightly mobile would be in favour of its being a portion of a tooth, whereas a rigid and less dense substance would be more likely to be the tooth socket.

Where a portion of the alveolus has become separated, this will generally convey the impression of a substance softer and more porous than tooth, especially if the separation is not recent, and its mobility will not be restricted, particularly in any one direction.

A portion of a healthy root will present a white, ivory appearance, with a dark centre—the root canal—and will yield slightly in a lateral direction. Radiography may be the only means of clearing up any doubt.

The margins of a root become better defined, and its characters more easily determined, after drying with cotton-

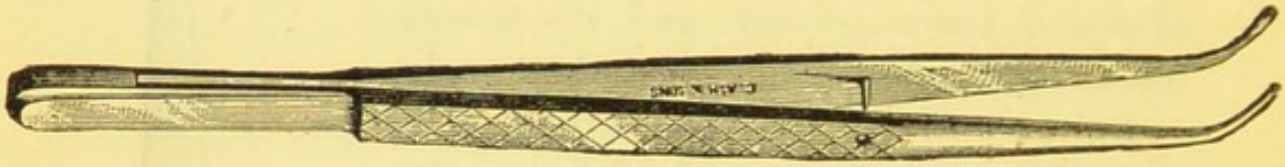


Fig. 2.—Tweezers.

wool. For this purpose tweezers are useful, and a mirror necessary for the back of the mouth (Figs. 2 and 3).

The following conditions must be observed in order to carry out the operation of extraction successfully:

1. Instruments, before being introduced into the mouth, should be rendered *sterile* by boiling in water for at least

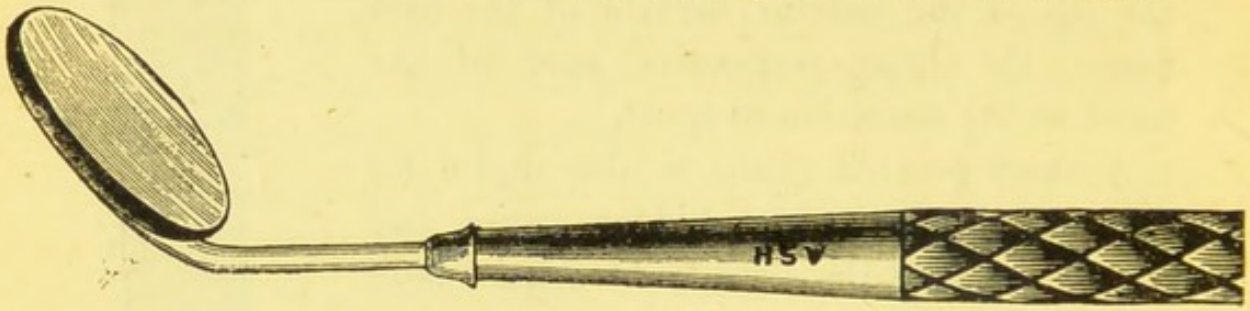


Fig. 3.—Mouth Mirror.

three minutes. They may then be transferred to some sterile solution. This applies to all instruments except those termed "cutting instruments"—*e.g.*, scalpels; for these we must rely chiefly on chemical sterilization, as boiling injures their sharpness.

A small quantity of soda is added to the water to prevent rusting of the instruments and for removing grease; it likewise raises its boiling-point.

2. The offending tooth should be removed in its *entirety*

with the least possible injury to surrounding parts, and as rapidly as is consistent with safeness.

3. The after-treatment must be directed to keeping the mouth and wounded parts *clean*, and so reducing any liability to septic infection.

By carrying out the above principles, the patient will be spared unnecessary pain at the operation, and subsequently during the healing of the wound.

The teeth are retained in the jaws partly by their shape, for in a dried skull those which have their roots dovetailed into the jaw will remain *in situ*, whereas others will drop out by their own weight.

The chief bond of union, however, is their attachment by a strong membrane—the *alveolo-dental periosteum*—to the alveolus in which they lie, and it is the yielding of this membrane and the surrounding bone which allows the removal of a tooth.

In proceeding to consider the operation of extraction, it is desirable first to describe the instruments employed.

Formerly one instrument, named the key, was largely used, but this had grave objections, the chief of which were:

1. It was not accurately adapted to each tooth, and, therefore, touching only at a few points, acted mostly like a cutting instrument, either slipping off from or fracturing the crown.

2. When once applied to a tooth, the force exerted could only be in one given direction, and this might happen to be that in which the greatest resistance was offered.

3. The fulcrum of the instrument was applied on a soft tissue, the gum, which was mostly bruised, or sometimes lacerated.

The credit of introducing forceps adapted to the necks of the teeth is due to the late Sir John Tomes.

The forceps is a modified pair of pincers, and consists essentially of the same parts—viz., a pair of blades or jaws with handles, which meet and cross each other at the hinge; each half becomes a lever of the first order, having its common fulcrum at the hinge. The instrument should be of the best steel, and the blades or grasping portion so tempered as to bend slightly, rather than break, if any unusual force be encountered.

Besides being made to fit accurately to the neck of the tooth for which the instrument is constructed, they should be thin and sharp at their edges, so as to detach the gum margin, and enter, when desired, between the root of the tooth and its alveolus. The blades should be of polished steel, and not be nickel-plated, as this adds no strength, renders the blades less sharp, and is liable to chip off, especially at the points. If lacquered instead of being nickeled, the handles are less slippery and afford a better grasp, but are more difficult to clean.

When closed upon a tooth, the blades should rest parallel on its root for some distance, and not merely touch at their edges, and be free from impinging upon the crown. The blades should be no longer than is necessary, as power is thereby lost, and long blades will often bend upon the neck of a very firm tooth instead of moving it.

The hinge should be strong, and not liable, when closed, to include portions of the cheek.

A slight amount of *lateral movement* in the hinge is advantageous, as no two teeth are exactly alike, and this slight range of movement will allow the blades to adapt themselves more accurately to any given tooth.

Recently tooth forceps have been constructed in which the blades take apart for cleanliness, but beyond this advantage they have not met with much favour.

In constructing the adapted forceps, it is usual, after

forging and fitting the blades as nearly to the required shape as possible, to fit them still more perfectly by applying them to the neck of a normally formed tooth coloured with pigment; the spots marked by the pigment are cut away, and the process continued until an almost perfect adaptation is attained, after which the instrument is hardened and tempered.

Thus constructed, the blades should fit accurately upon the external and internal surfaces of the neck of the tooth; but as these do not always bear the same relative position to each other, the small amount of play at the hinge, as mentioned above, is useful in allowing the blades to accommodate themselves to this departure.

The handles should be strong, broad, and roughened, but not deeply serrated, for this will make cleanliness difficult. The handles should be sufficiently long to afford a firm grasp, but no more, for although length in the handles gives greater power, they make the instrument cumbrous, and interfere with delicacy of movement.

The operation of tooth extraction may be divided into *three stages :*

1. The application of the forceps to the tooth.
2. The destruction of its membranous connections and dilation of the socket.
3. The removal of the tooth from the socket.

In the *first stage* the instrument should be taken in the palm of the hand, the blades pointing upwards or downwards, according to the jaw operated on, the thumb being employed as a stop or regulator to govern the amount of separation of the handles, and consequently of the blades (Figs. 4 and 5).

The blade should be first adapted to the most obscured side of the neck of the tooth, and then lightly closed upon the opposite side. This being done, the thumb is gradu-

ally withdrawn, and steady but forcible pressure made in the direction of the root of the tooth. The force employed should be *regulated* by the amount of resistance experienced, it being applied gently and increased as the case demands, and often accompanied to advantage by a very slight rotatory movement.

Experience will enable the operator to tell when this has been accomplished to the proper extent. The tendency in a beginner is to force the blades insufficiently up the socket of a tooth, and so to obtain only an edge grasp on the neck of the tooth, with the probable result of fracture at this point. If the tooth be already loose, and especially if it be one with a single root, there is no need to push the blades up the socket to any extent, and doing so only causes unnecessary pain.

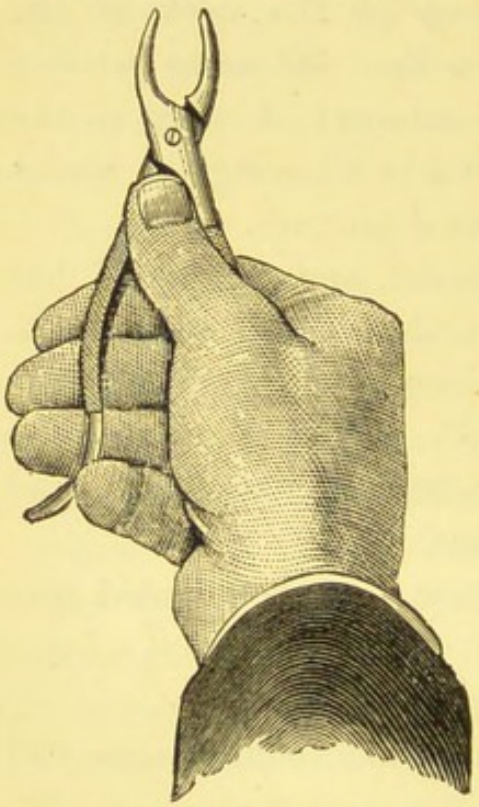


FIG. 4.—SHOWING METHOD OF HOLDING UPPER FORCEPS.

The operator must judge as he progresses how much force is required, commencing gently, but continuing to increase the force until the object in view—viz., a firm grasp of the tooth—is obtained.

Perhaps more *judgment* is required in this portion of the operation than in any other, and it must be admitted that, if it be unskilful to use unnecessary force in obtaining a firm grasp, it will prove more unfortunate to err on the other side, and cause fracture of a tooth by employing too little. The tooth being grasped at the right spot, it

must be retained by a force sufficient to prevent the instrument from slipping, but not so great as to endanger the tooth.

The *second stage* of the operation, the severing of the tooth from its membranous attachment and dilation of the socket, is now commenced. This will consist in a slight rotatory movement if the tooth has a conical root, or an inward and outward movement—*i.e.*, at right angles to the dental arch—if the root be flattened, or if there are two or more roots.

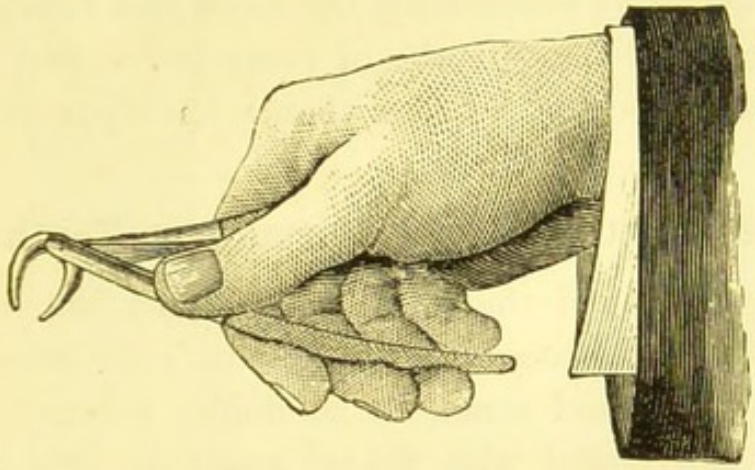


FIG. 5.—SHOWING METHOD OF HOLDING LOWER FORCEPS.

In making these movements we should follow certain general directions to be presently mentioned; but if we fail with moderate force to cause the tooth to yield, we may employ the force in other directions, gradually increasing it as we find our efforts availing.

The yielding of the alveolo-dental membrane and surrounding bone of the socket gives a sensation which we can readily perceive, and when the membrane is sufficiently severed, and the socket dilated, we commence with our movements of detachment or those more truly extractive, the *third stage* of the operation.

Judgment must be exercised here, too, for if the extractive

force be applied too soon, great resistance will be experienced, and fracture of the tooth liable to occur if the force be continued; if applied too late, much unnecessary pain is inflicted. Error in the former alternative is likely to be attended with the unwelcome exhibition of portions of the alveolus. The extractive force should as a rule be exerted chiefly in the direction of the long axis of the tooth; but it is a rule with many exceptions.

The skilful operator will judge in what direction the loosened tooth is coming most readily, and he should exert the traction in the direction of least resistance. Throughout the extractive movements the tooth and forceps should be as one body and partake of every movement; nothing is more productive of fracture than a loosely fitting instrument.

Extraction of the Permanent Teeth.

Having described the mode of applying the forceps in general, we now proceed to explain its *application* for individual teeth, and must, in so doing, assume that the reader is conversant with dental anatomy, and fully acquainted with the forms which the teeth in man present.

Maxillary Incisors and Canines.

Horizontal sections of these teeth at their necks (Fig. 12), present an almost circular form, the anterior and posterior aspects of which are arcs of a circle, the anterior a rather larger one than the posterior. The blades of the forceps must be constructed to correspond with such forms, and to cover, when applied, rather more than a third of the circumference of the tooth grasped.

Should the blades of the forceps used be too narrow, there will be a tendency for the blades to swing round the root without moving it when rotatory movements are applied.

In the perfect instrument the inner blade should represent a less obtuse angle with the inner handle than the outer blade does with the outer handle; in accordance with the form presented by the roots of these teeth, however, the difference in angle required is so slight that the blades

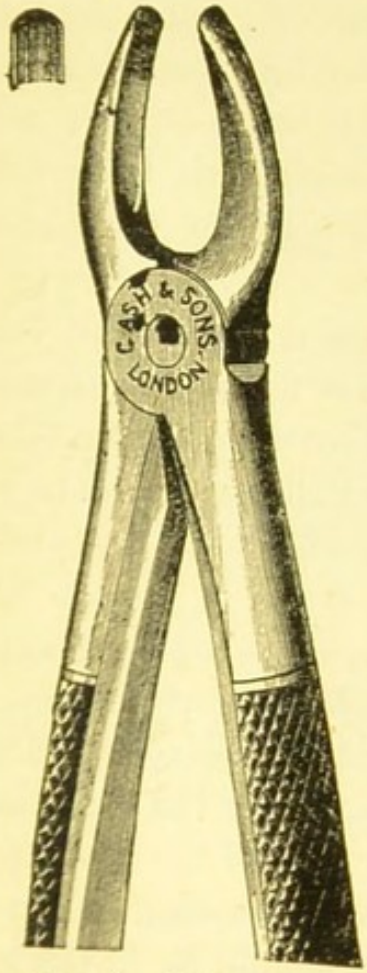


FIG. 6.—MAXILLARY INCISOR FORCEPS.

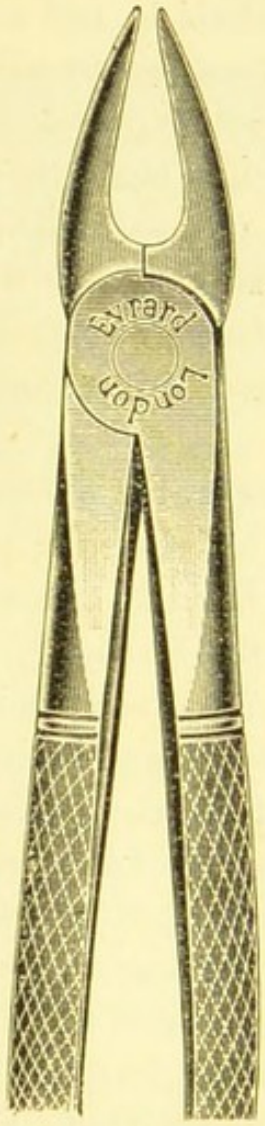


FIG. 7.—MAXILLARY INCISOR FORCEPS (NARROW-BLADED).

are generally made similar in this respect, which in practice is perhaps an advantage (Fig. 6).

Whilst the same instrument may be employed for the above teeth, a pair with narrower blades are desirable for *lateral incisors* (Fig. 7).

The operation of extracting these teeth is thus performed: The patient should be seated and facing a good light, his head supported in a slightly extended position and about on a level with the operator's shoulder. This position will be found convenient for all the maxillary teeth. If a dental chair be not available, a large arm-chair, provided with a cushion to raise the body so that the head may partly recline on the top, will answer sufficiently well.

If such a chair be not procurable, the following device may be adopted: The patient is seated on an ordinary chair, whilst the operator firmly places his left foot on a second chair placed at the back, and covering his knee with a towel, makes it a soft but firm support for the patient's head.

The operator should stand rather in front, and on the patient's right side, placing the first finger and thumb of the left hand on either side of the alveolar process surrounding the tooth (Fig. 8). This method allows the tooth to be clearly seen, and affords some knowledge of the yielding of the tooth and its socket.

The forceps, held as before directed, should be applied to the neck of the tooth, to its posterior surface first, and then closed gently upon it by the thumb being withdrawn. The instrument is now forced upwards in the direction of the long axis of the tooth until the edge of the alveolus, or, if the tooth be much decayed, a point beyond, is reached. As a rule at least *a third of the root* should be in the grasp of the forceps.

The tooth being firmly grasped, slight rotation in one direction is attempted; but if much resistance be encountered the rotatory movement is reversed, and if still resisted, it may be exchanged for an inward or outward one—*i.e.*, to and from the centre of the palate—coupled with a return to the rotatory movement. A pronounced

inward movement, even at the commencement, often has the effect of immediately loosening the tooth. The palatine wall of the socket does not readily give, so that the tooth is not overstrained by this movement. As the tooth begins to yield from its attachments, the force may be

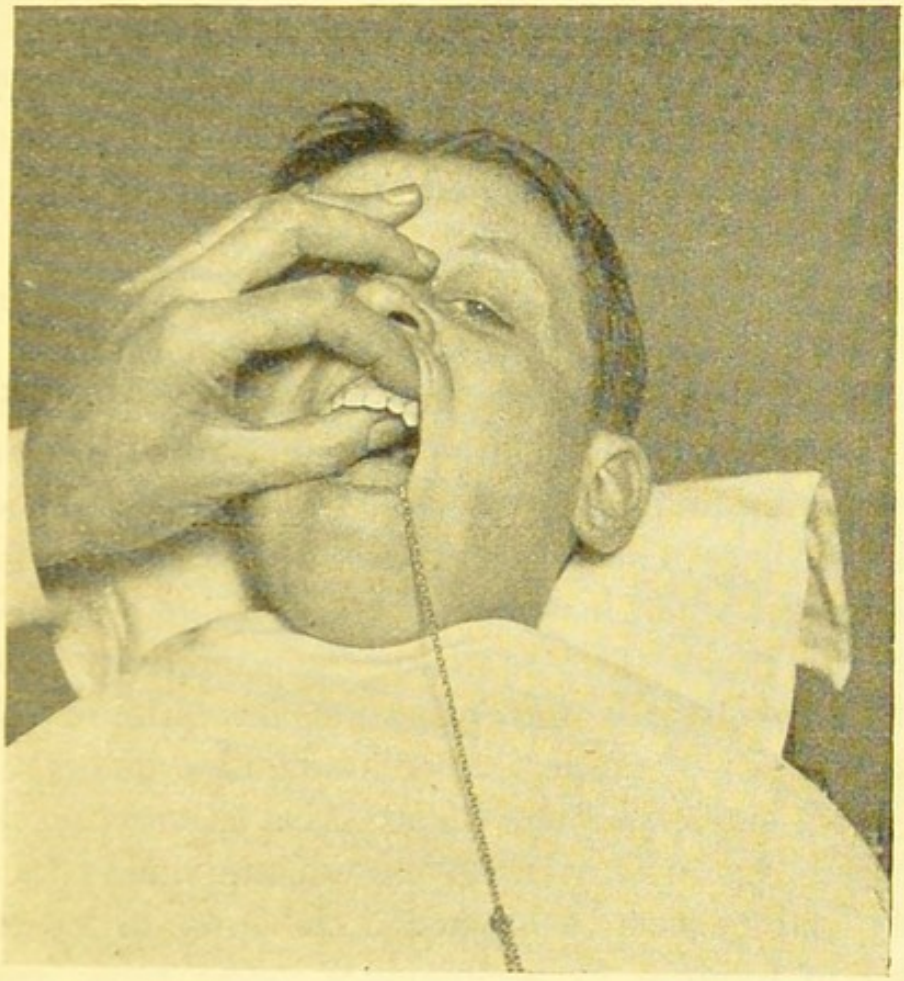


FIG. 8.—SHOWING POSITION OF FINGERS OF LEFT HAND FOR THE REMOVAL OF A MAXILLARY INCISOR OR CANINE.

The prop is inserted on the left side, to allow more room for the fingers.

gradually changed to a downward one in the direction of the long axis of the tooth; but it should be steady and guarded, inclining to the direction in which the tooth seems most willing to yield.

Not infrequently a maxillary incisor will shoot from its

socket, owing to its root sliding along the double-inclined plane formed by the blades of the forceps, an occurrence not always possible to avoid, but one which we should do our utmost to prevent, as the tooth may disappear into the throat, or even into the larynx. Some indication that a tooth is likely to suddenly shoot out may be afforded by the fingers on either side of the alveolus, and these may also prevent the tooth falling into the throat. More force will be necessary for the removal of the canines than for the central incisors, and more in the case of the latter than the lateral incisors.

Roots of maxillary incisors and canines: Thus far it has been assumed that the teeth on which we have been operating are fairly strong ones, not diseased or injured much below the level of the gums. When teeth in the latter condition present themselves, our instruments as well as our lines of operation must be somewhat modified.

The blades of our instruments must be slighter and more pointed to enable them to divide the membranous attachments of the tooth and penetrate far into its socket. The remainder of the instruments—handles, hinges, etc.—may be of much the same construction as those for sound teeth (Fig. 7). The severing movements should be more gently and cautiously performed, in order to lessen the danger of fracture by occupying a longer time; and the same considerations should influence us in the extractive movements.

If the strength of a tooth be doubtful, it is advisable to employ an instrument which, in the event of the tooth fracturing, would be serviceable for proceeding with the removal of its root or roots.

As the blades of instruments are constructed to fit the necks of the teeth, the same forceps may be used when this portion remains as would be applied to the sound tooth;

but should caries or injury have extended beyond the neck of the tooth, then instruments having thinner, sharper, and more pointed blades are to be preferred. The occasion for the change of an instrument should be anticipated before the tooth operated upon is endangered; otherwise, if the tooth be fractured, the landmarks for its roots may be obscured.

The forceps must be pressed well up into the socket

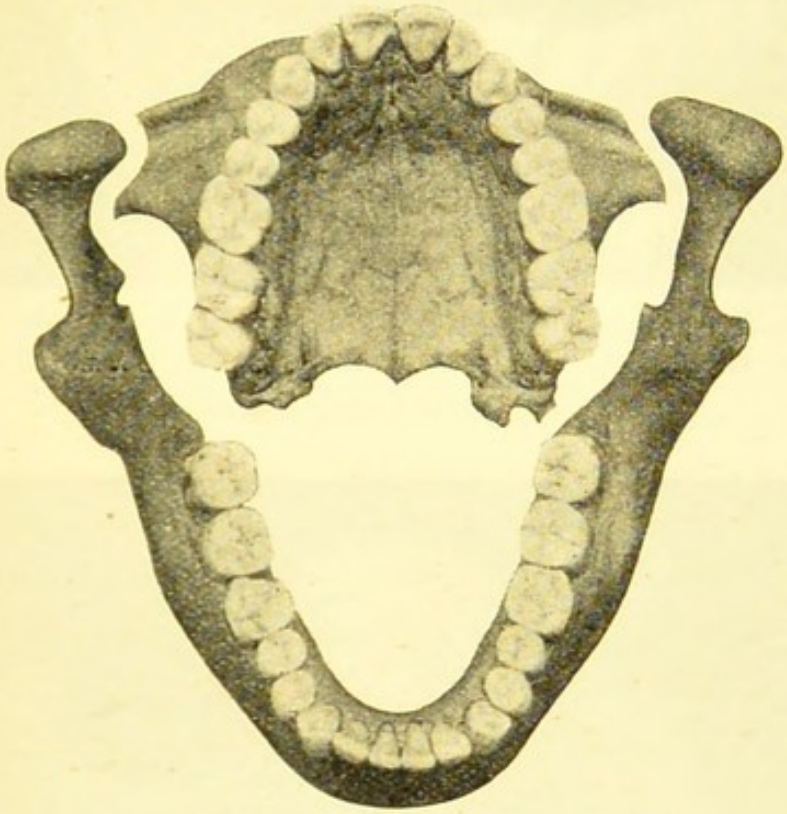


FIG. 9.—JAWS OF AN ADULT MAN.
(From Hopewell-Smith's "Dental Anatomy.")

and care exercised that they are neither too widely open nor too closely shut. The latter is the error generally made by a beginner, especially where there is no portion of the tooth visible above the gum, or only a portion of one side left to guide him, resulting in one or both blades of the instrument being forced upon the root itself.

The direction of the root or roots being ascertained or

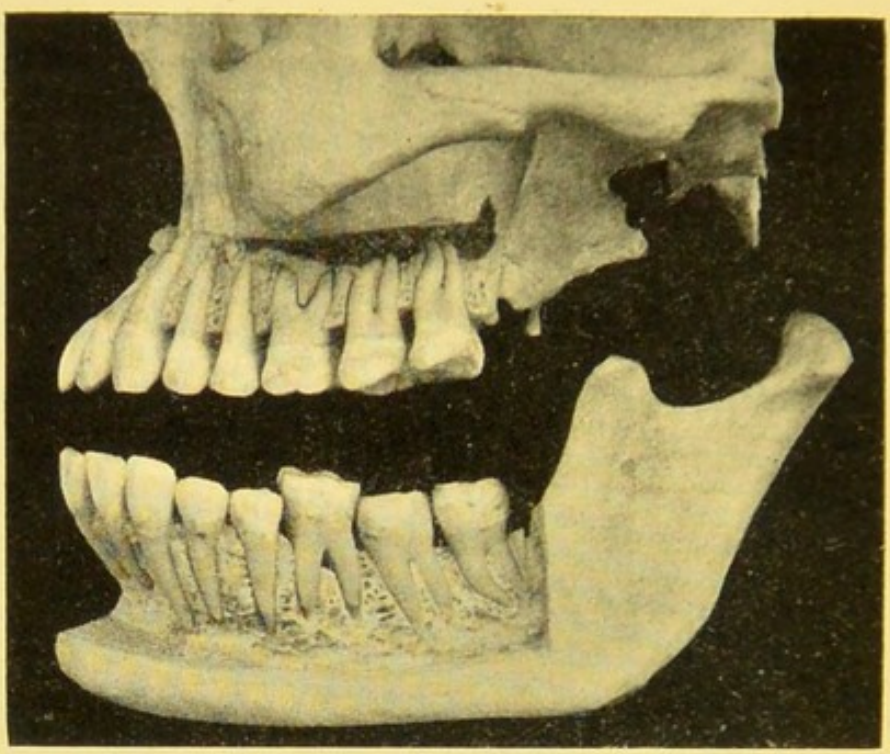


FIG. 10.—SHOWING THE LEFT HALF OF THE MAXILLA AND MANDIBLE WITH THE OUTER ALVEOLAR PLATE REMOVED.

(Royal Dental Hospital Museum.)

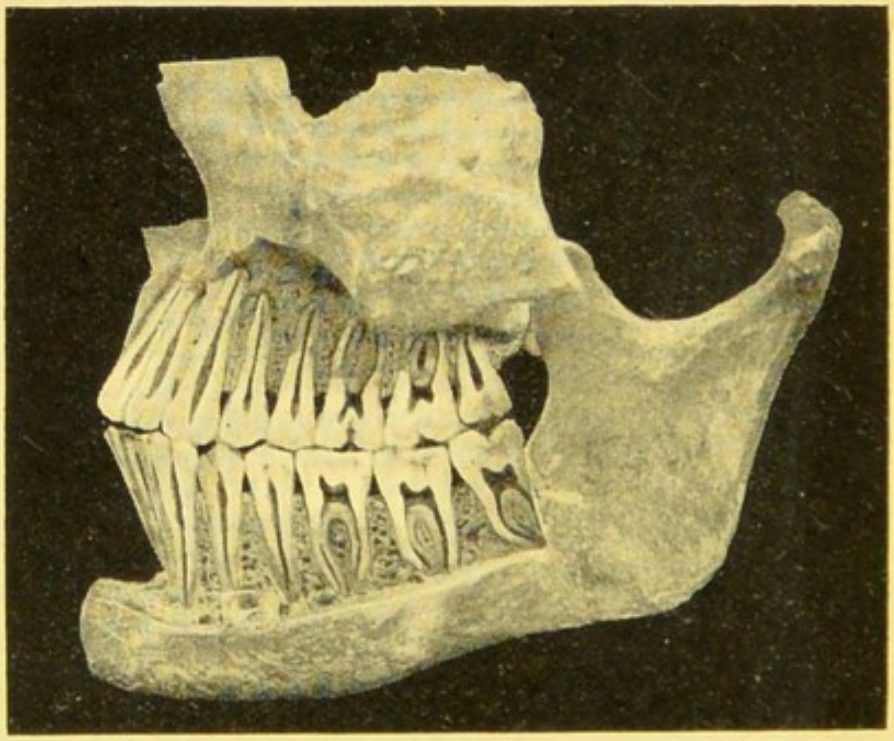


FIG. 11.—SHOWING A VERTICAL SECTION THROUGH THE ALVEOLAR BORDER OF THE MAXILLA AND MANDIBLE, WITH THE TEETH CUT IN SITU.

The teeth are shown in occlusion. (Royal Dental Hospital Museum.)

allowed for—and if a knowledge of dental anatomy be essential to insure a good extractor of teeth, it becomes of imperative necessity when hidden roots are operated upon —the instrument is forced upwards in the direction of the long axis of the root, this being often much assisted by a slight rotatory movement. The amount of pressure necessary will be determined by the resistance offered and the degree of caries. The roots of these teeth may be hollowed out to such an extent that little more than a shell-like covering remains.

In these cases it is essential to press the blades of the forceps cautiously well up the socket of the tooth, so that at least two-thirds of the root below the gum are grasped by the forceps (Fig. 25), and to err, if anything, in having the blades of the forceps open a little too wide, gradually closing them on to the root when the blades are pressed up sufficiently far.

Even if a small portion of alveolus is included on either side, it will tend to act as a splint in keeping the hollow root intact, whereas to err in not opening the blades sufficiently wide would be fatal in crushing up the root.

These precautions apply particularly to those cases where the root cannot be definitely defined.

A tooth may be so frail that it cannot be used as a force for dilating the socket, and this part of the operation must be accomplished by pressing the blades of the forceps nearly to its apex without encroaching on the root; or, in other words, a trench is prepared around the root, so that the latter may almost drop out by its own weight or with but little assistance from the forceps (Fig. 25).

If the root breaks up even under these precautions, the method of raising the apex of the root by an elevator passed through the alveolus (p. 41) may be applied.

Some have advised filling these roots with gutta-percha,

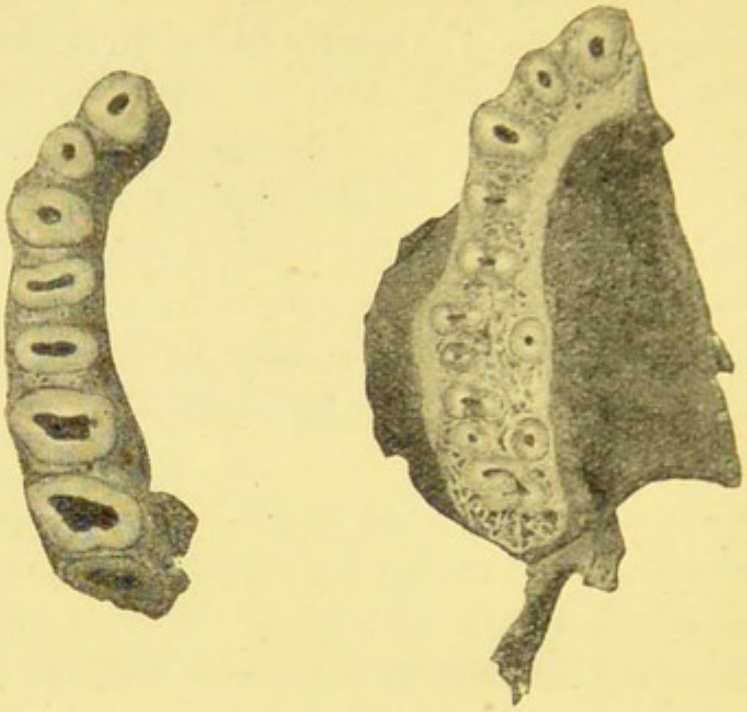


FIG. 12.—SHOWING HORIZONTAL SECTIONS OF THE RIGHT MAXILLARY BORDER AT THE LEVEL OF THE NECKS OF THE TEETH, AND AT THE LEVEL OF THEIR ROOTS.

(Royal Dental Hospital Museum.)

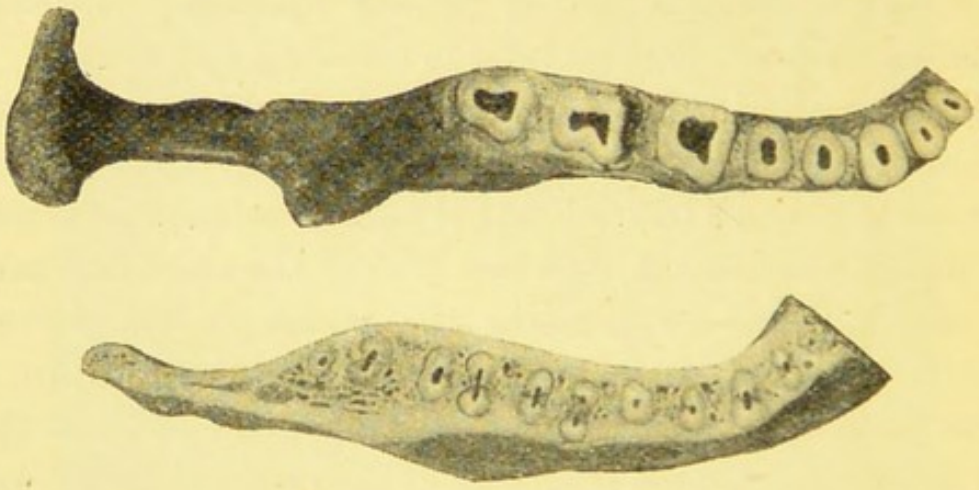


FIG. 13.—SHOWING HORIZONTAL SECTIONS OF THE RIGHT MANDIBULAR BORDER AT THE LEVEL OF THE NECKS OF THE TEETH, AND AT THE LEVEL OF THEIR ROOTS.

(Royal Dental Hospital Museum.)

or a quick-setting cement, to render them less frail, but this produces a false solidity, and, if the above precautions be taken, will not be required.

Instruments known as the screw forceps and the screw have been advocated for the removal of hollow roots, but their application necessitates sufficient strength of the root to allow its removal by other and more reliable methods, if intelligently employed.

FIG. 14.—THE PERMANENT TEETH OF THE LEFT SIDE OF THE MAXILLA AND MANDIBLE.

1, Central incisors; 2, lateral incisors; 3, canines; 4, 5, premolars; 6, 7, 8, molars.

Fortunately, the bony alveolus around hollow roots is usually partially absorbed and rarefied by inflammation, and so offers but little resistance to the upward thrust of the forceps and the dilation of the tooth socket.

Having cautiously secured a firm hold of the root, proceed gently to make the same rotatory or other severing movements as the case demands, followed by extractive ones.

Maxillary Premolars.—Sections of these teeth at their necks (Fig. 12) are of a less circular form than those just considered, and instead of having an almost conical root, have a somewhat flattened one, the teeth being broadest between their external and internal surfaces. In the place of one root there may be two, or rarely three, this variation being more common in the first than in the second premolar (Fig. 14).

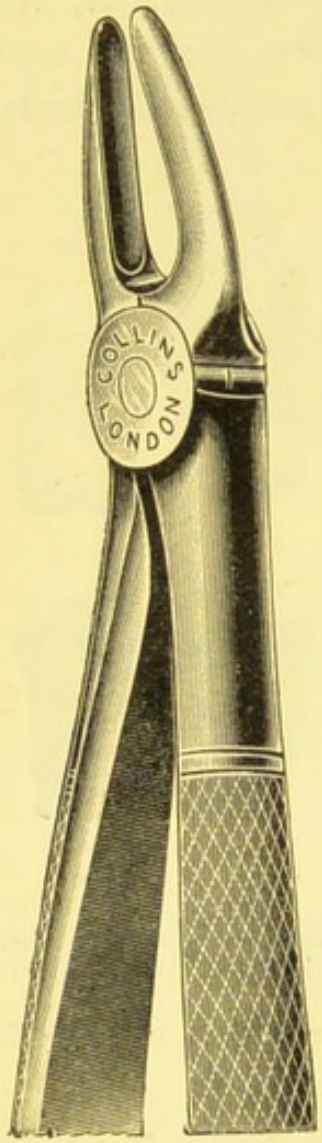


FIG. 15.—MAXILLARY PREMOLAR FORCEPS.

The instrument employed must have blades which are segments of the circles presented by the external and internal surfaces of these teeth at their necks, and for all practical purposes segments of the same circle will suffice, otherwise we should require a pair for each side of the mouth, as the handles are set at a slight angle to the blades, in order to clear the lower lip during the operation. The breadth of the blades should be about the same as in the instrument used for lateral incisors (Fig. 15).

Any angle which the blades form with the handles should take place at the joint; the blades themselves should always be in a straight line.

The operator assuming the same position as that described, which is generally best suited to the removal of all the maxillary teeth, applies the instrument to the tooth and forces it upwards into the socket (Figs. 16, 17). The severing movements must be accomplished by force exerted to and from the palate,

and preferably in that order—*i.e.*, first inward towards the palate, followed by a more forcible movement in the opposite direction; rotation is not available for maxillary premolars. Their flattened roots, and the circumstance of their sometimes having two roots, would offer great resistance to such movement. The reason for applying the inward movement first is that this movement is restricted in its extent by the dense inner alveolar plate, so that the tooth is not overstrained, while the amount of resistance encountered forms an indication of the firmness of the tooth. If the bone be yielding, as in a child, or the tooth slightly loosened from periodontitis, a single outward movement will often suffice for its removal; whereas to force the outward movement to this extent, without the previous knowledge gained of the resistance of the tooth, would frequently lead to its fracture. As the tooth yields the extractive force may be commenced, and in the line of the long axis of the tooth, or varied, as resistance may indicate, and with it a slight rotatory movement may be advantageously combined.

If the mouth can be widely opened, so that the inward movement of the instrument is not impeded by coming into contact with the lower lip, a *straight* pair of forceps may be used for the first or even the second premolar.

The roots of maxillary premolars require blades possessing the same characters as those already described.

These teeth frequently have two slender roots, especially the first premolar, and by their divergence afford a less perfect grasp than in the case of a single and more conical root; also, when grasped, the two roots frequently become detached, and moving one upon the other, cause the instrument to slide off them.

Forceps having fine and long-pointed blades may here

be advantageously used for removing each root separately (Fig. 24).

The **maxillary molars** present on section at their necks a more varied figure than the foregoing—viz., in the external surface being a segment of two circles united at one

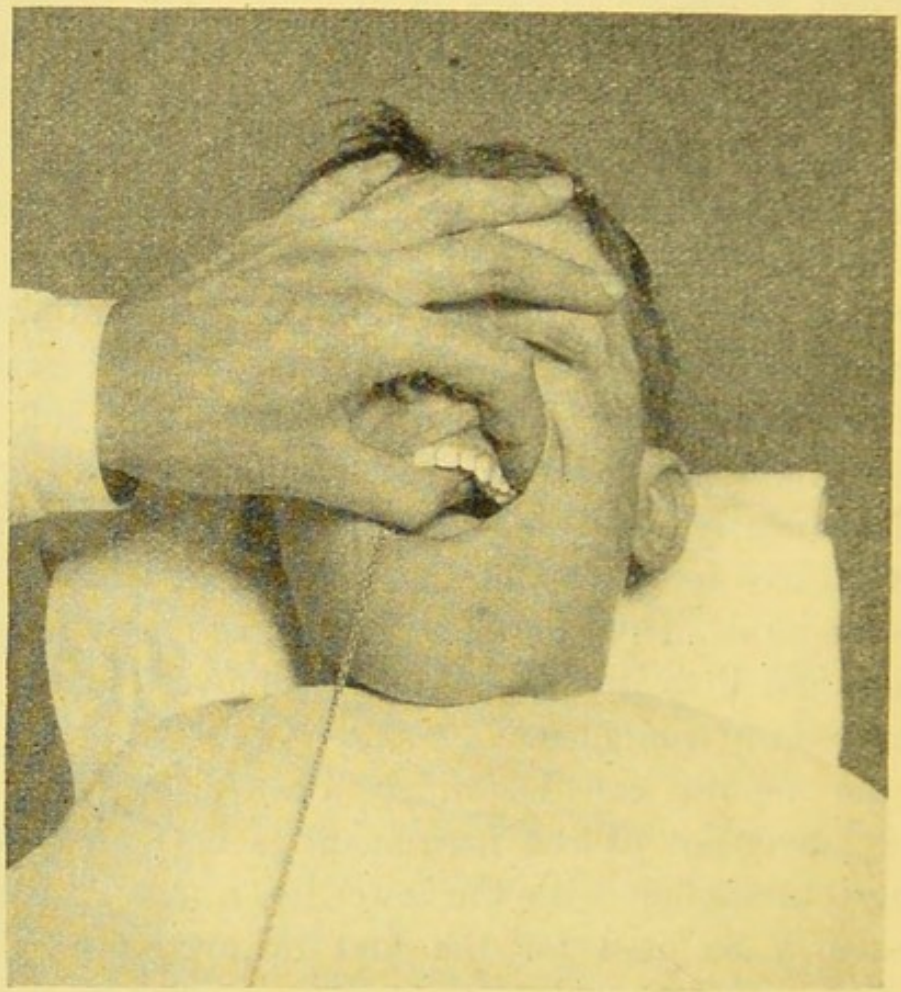


FIG. 16.—SHOWING POSITION OF FINGERS OF LEFT HAND FOR THE REMOVAL OF A LEFT MAXILLARY PREMOLAR OR MOLAR.

extremity, of which the anterior segment is rather the larger, whilst the internal surface represents the segment of a circle larger than either (Fig. 12).

In conformity with these circles must be the blades of the instrument, which are broader and somewhat stronger than those already considered, as should be the instrument generally; it will also be desirable to have the blades at

a greater angle with the handles than in the instrument last described (Fig. 18). In addition to this angle, some prefer a *curve* in the handles, the convexity of the bend being towards the roof of the mouth when the instrument is employed. The inner or palatine blade is

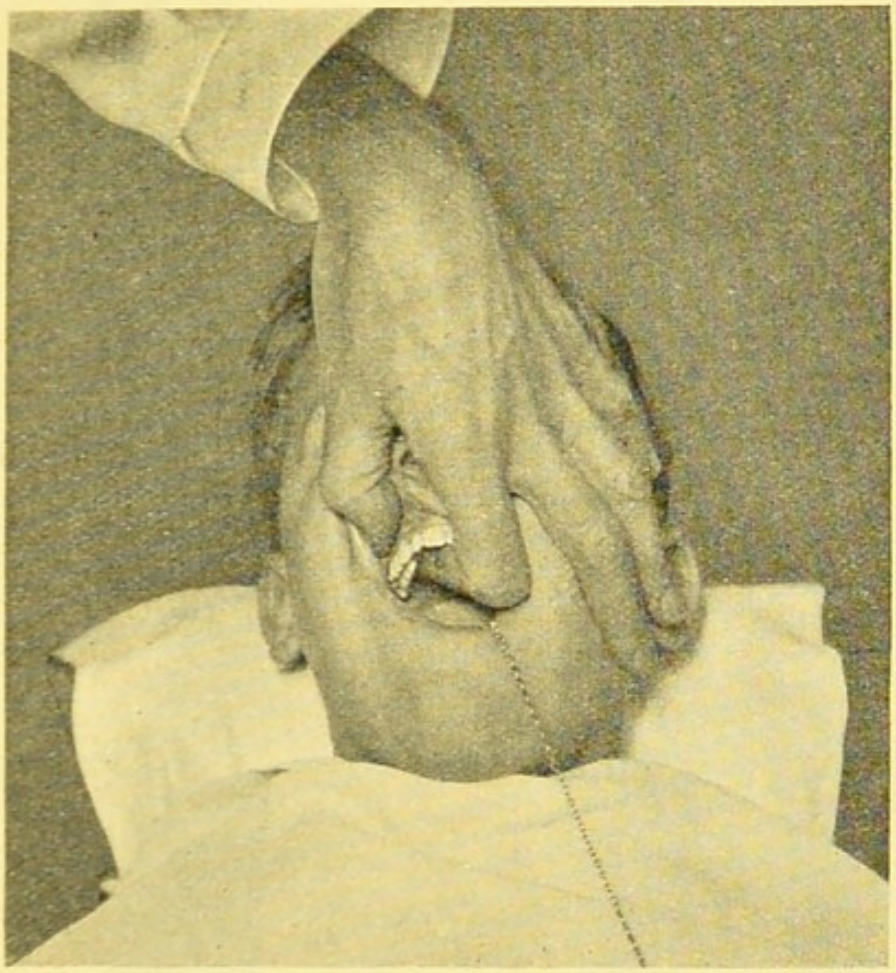
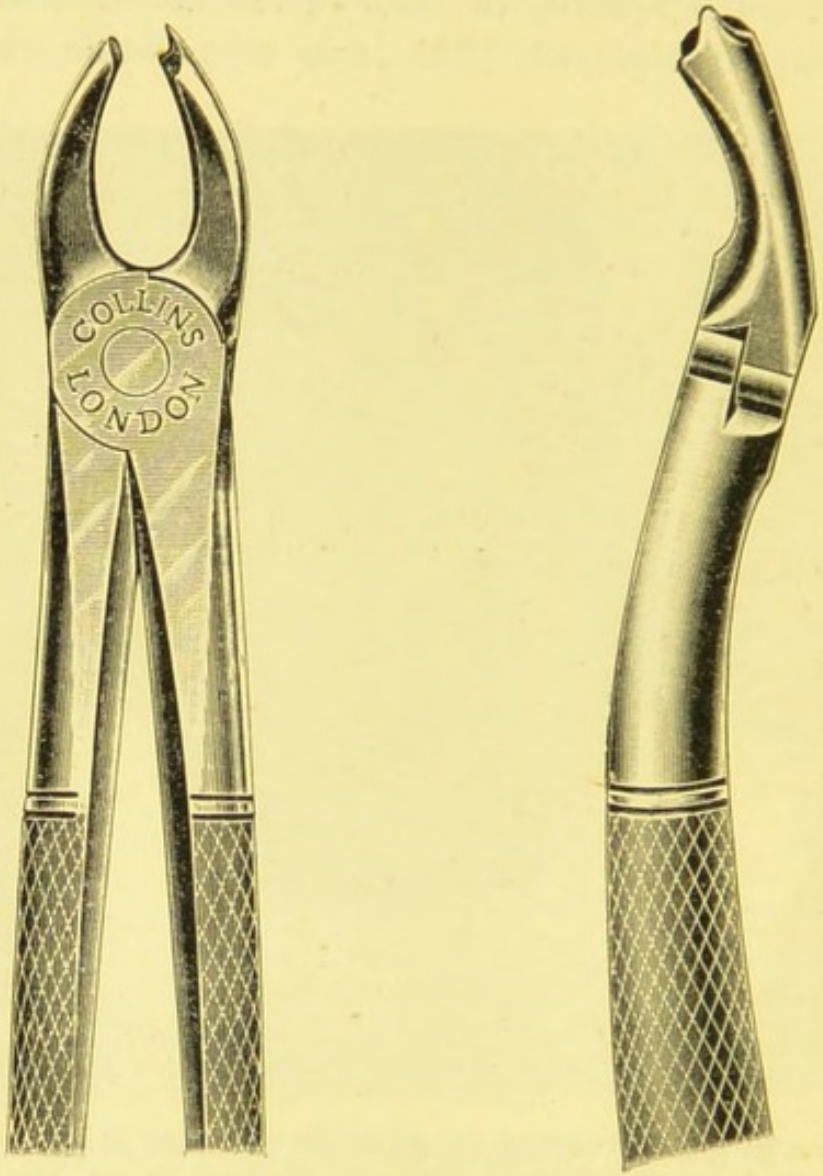


FIG. 17.—SHOWING POSITION OF FINGERS OF LEFT HAND FOR THE REMOVAL OF A RIGHT MAXILLARY PREMOLAR OR MOLAR.

generally made too concave, whereas this blade should be nearly straight, or even slightly everted towards the tip, in conformity with the root it grasps. The intercircular point on the outer blade need not be pronounced, as it adds no advantage in grasping the tooth, and if much incurved is a hindrance in applying the instrument.

In removing a tooth of such dimensions and resisting

form as a maxillary molar, we must be prepared to exert a larger amount of force than upon smaller and less firmly implanted teeth, and this especially in grasping them, when



A. *B.*

FIG. 18.—SHOWING CORRECTLY DESIGNED MAXILLARY MOLAR FORCEPS.

A, Front view (note the amount of curvature of the palatine blade). *B*, Side view.

a very slight rotatory movement accompanying the forcing upwards of the instrument will often prove advantageous. From the direction of the roots, it is apparent that only an inward and outward movement is feasible, commencing

for the reasons given with the former; it is not, however, to be persisted in until some movement is effected, for, should this not come fairly readily, then the outward movement is to be adopted, and with this a moderate amount of force exerted in the downward direction.

The lateral movements have generally to be repeated before the truly extractive ones can be attempted. A slight rotatory movement when the tooth is fully brought outwards will frequently readily disengage it from its socket. This slight rotatory movement has the effect of dilating a tooth socket and unlocking a curved root.

Here we have, besides the strong membranous attachments, to overcome the *dovetailing* of the roots and alveolus, consequently the latter must be dilated in most cases. Fortunately, the surroundings of a tooth yield fairly readily, especially when inflamed.

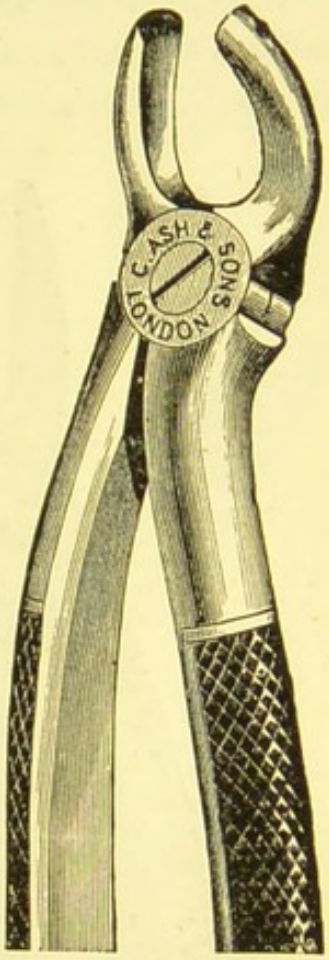


FIG. 19.—MAXILLARY THIRD MOLAR FORCEPS.

The second maxillary molar may be removed precisely in the same manner and with the same instrument as the first; generally more readily, as the tooth is not so large nor its roots so divergent (Fig. 14).

The third maxillary molar has the two external circles at its neck so feebly pronounced (Fig. 12) that an instrument, both blades of which are segments of one large circle, will be found well adapted to it, and may be employed for either side (Fig. 19). If preferred, an instrument similar to that used for the first and second molars may be employed, but in either case the handles should form a considerable angle

with the blades, otherwise it will be difficult to adjust them accurately, and to apply the extractive force in the vertical axis of the tooth.

Except from their inaccessibility, the third maxillary molars are not as a rule difficult teeth to remove; their roots, if not agglutinated, are generally but slightly divergent

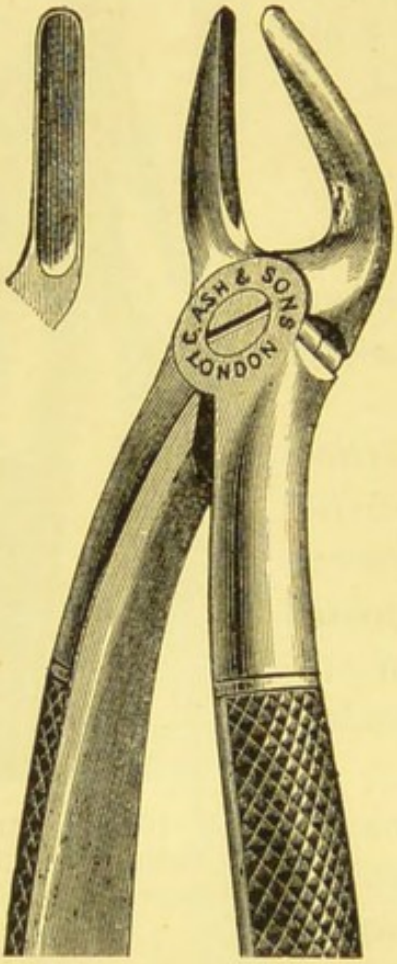


FIG. 20.—MAXILLARY MOLAR ROOT FORCEPS.

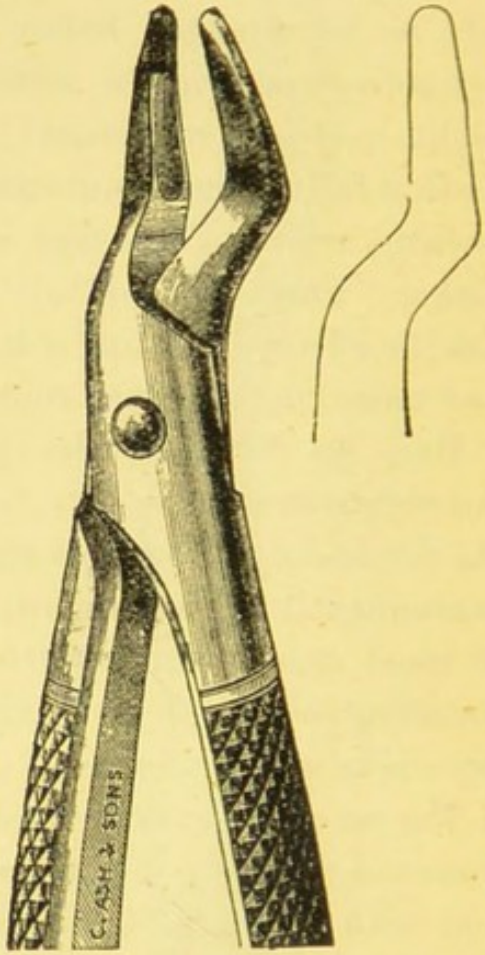


FIG. 21.—MAXILLARY MOLAR ROOT FORCEPS.

(Fig. 14), and the bone in which they are placed is *soft and spongy*. The movements of detachment and removal may be combined in an outward and downward one from first to last, owing to the direction of their long axis; indeed, a circle passing from the crown of the tooth downwards, outwards, and upwards, in the direction of the zygomatic

process, would represent an extension of the curve that the tooth often assumes in its socket.

Maxillary molars that are carious or injured to the gum margin may give rise to some difficulty in extraction if their roots be much divergent and firmly attached to one another.

Such a tooth roughly represents an inverted truncated cone, and the forceps to employ for their removal must possess blades capable of wide separation, so that when opened and forced up the socket they lie parallel with the tooth rather than acting as excising forceps on its roots (Figs. 20, 21).

A further advantage is obtained in the ease with which such a blade can be pressed up into the socket.

Splitting forceps have been designed for separating such roots, having the palatine blade of much the same form as in those last described, whilst the buccal blade terminates in a vertical cutting edge, which, when closed, approaches within a short distance of the former (Fig. 22). The palatine blade is first adjusted to the tooth and then the outer blade closed upon it, generally in such application dividing a portion of the mucous membrane and the thin outer edge of the alveolar process. The sharp outer blade cuts between the two external roots on firmly closing the handles and penetrates the palatine root, which is generally brought away in the forceps,

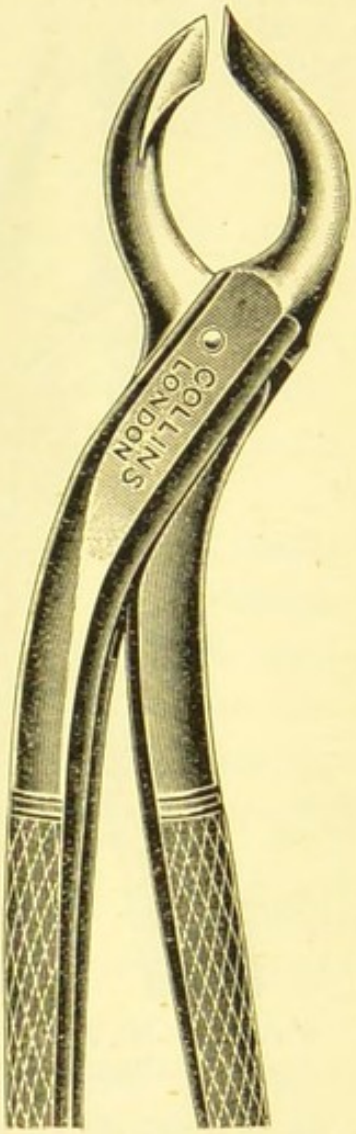


FIG. 22. — SPLITTING FORCEPS FOR MAXILLARY MOLARS.

and the operation is concluded by removing the separated external roots with root forceps.

The same end is usually attained by using root forceps, with the additional advantage that the three roots may be removed intact.

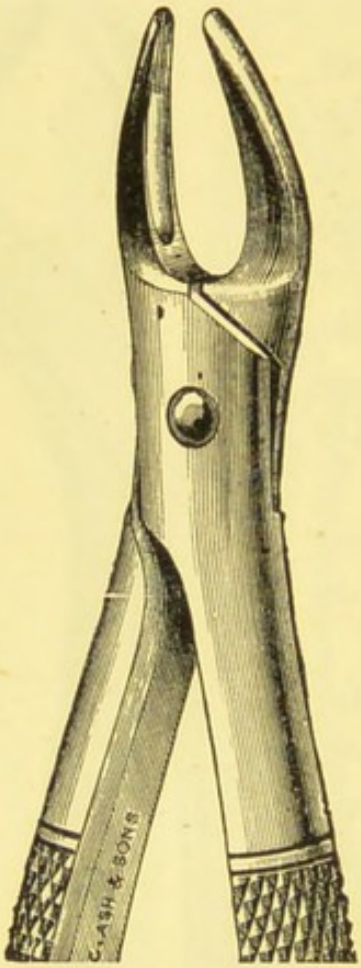


FIG. 23.—MAXILLARY ROOT FORCEPS.

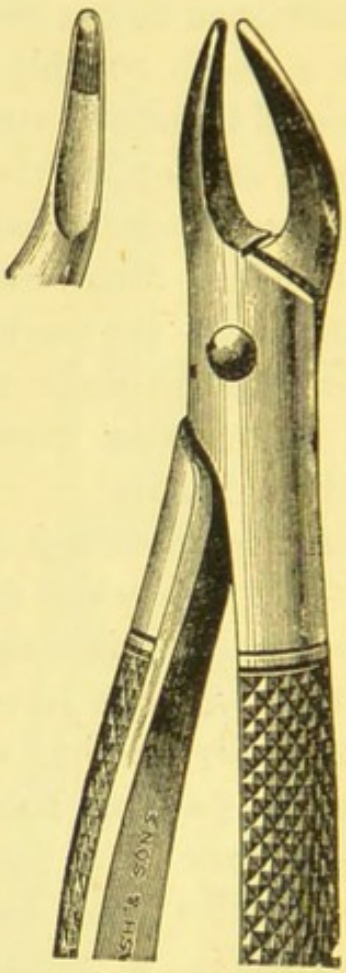


FIG. 24.—MAXILLARY ROOT FORCEPS (FINE-BLADED).

The varieties of instruments devised for the extraction of such roots afford evidence of the difficulties that have been met with by practitioners.

If the destruction of the tooth has advanced further, so that the roots are barely attached to one another or insufficiently attached to remain intact during the extractive movements, the operation may be readily accomplished with root forceps (Fig. 23), by giving to the instrument a

rotatory movement when each root is separate, but otherwise passing through the same extractive movements as in dealing with maxillary molars, except that the range of movement should be somewhat curtailed.

The roots of maxillary third molars: These are generally less divergent than those of the first and second molars, and, except from their position, are not difficult to remove.

An instrument somewhat similar to that used for upper premolars, but having the blades bent up at a greater angle to the handles, may be employed. The handles should be curved on themselves to avoid bruising the lip, and the blades when opened should lie nearly parallel with each other (Fig. 20).

This form of instrument was devised by Alfred Coleman. The same idea has since been carried out by introducing a second angle in the blades in place of the compensatory curve of the handles (Fig. 21). This has the disadvantage of throwing the hinge farther away from the blades, with consequent loss of power, but is advantageous in allowing greater separation of the blades.

By either of these means an instrument is constructed the blades of which can be applied in the correct axis of the root, while the handles are clear of the cheek.

The same instrument may often be employed with advantage for the other maxillary molars when carious to the same extent, and when firmly thrust up the socket will seldom fail to bring away one, two, or all the roots at once.

For the roots of first molars an instrument with the blades at a less angle to the handles is preferable, and the latter may be either straight or curved at its extremity (Fig. 23).

For the roots of second molars the choice lies between these two forms, giving preference to the less curved

instrument when the mouth can be opened sufficiently wide and other conditions are favourable.

When the roots of maxillary molars are separate, but in close contact, it is usually advisable to open the blades sufficiently wide to include the palatine and one of the buccal roots, the posterior for preference, as this lies in closer alignment. In so doing, both roots are frequently removed together and the remaining root loosened, or one root will be removed with loosening of the other two.

By trying to pick out each separately, when the roots are close together, one blade of the instrument is liable to press on the surface of one of the remaining roots, especially when these are below the gum, and so prevent the instrument from passing down the socket. Subsequent hæmorrhage may make it difficult to define the remaining roots afterwards, whereas, if, in the first instance, the blades are widely opened to the outer limits of the stump, and pressed up in this position, any subsequent hæmorrhage will not materially interfere with the removal of any root left behind, as, their outer limits having been defined, we are given the area in which to seek the remaining root or roots.

When maxillary molar roots are separate, a useful plan is to remove first the posterior buccal, then the palatine, and lastly the anterior buccal root, utilizing the empty socket, if necessary, in removing the subsequent root.

The palatine is generally the most concealed root, and the socket of the posterior buccal root often forms a useful guide to its outer margin.

A pair of narrow maxillary incisor forceps is often useful or the removal of the palatine root; the axis of this oblique root is more easily obtained with this instrument, and there is not the same tendency for the blades to slip

towards the centre of the socket, as pertains with curve-bladed root forceps (Fig. 26).

The anterior buccal root, when close up against the premolar, requires forceps having the blades at a sharp angle to their handles to clear this tooth.

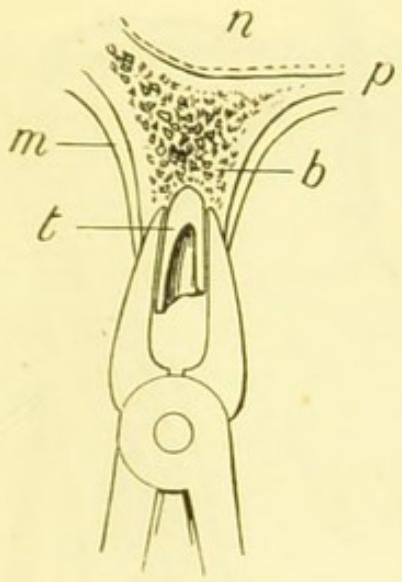


Fig. 25.

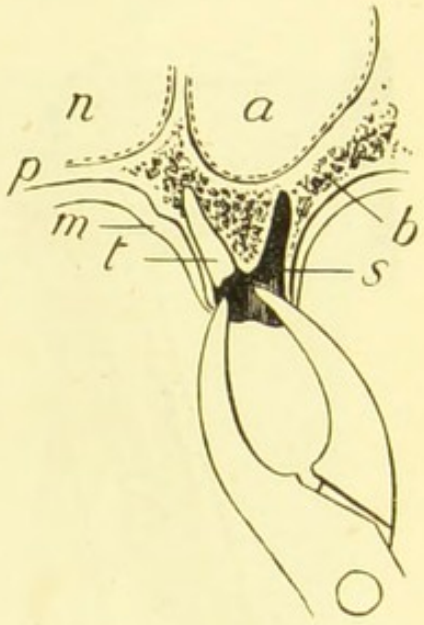


Fig. 26.

Fig. 25.—Showing the Forceps applied to a Hollow Maxillary Incisor Root.

Fig. 26.—Showing how Curve-Bladed Root Forceps may fail to grasp a Palatine Molar Root, unless the Palatine Blade be opened to include the Alveolus.

t, Tooth; *m*, mucous membrane; *b*, bone; *p*, palate; *n*, nasal fossa; *a*, antrum; *s*, socket of a buccal root.

When we operate upon the teeth of the *lower jaw*, the patient may be seated in an ordinary easy chair, provided there is some support for his head. The lower jaw should be about on a level with the operator's elbow. The patient's head should be in a line with the body, and his jaw slightly depressed, this position being the most advantageous for admitting light and permitting the operator's movements.

The Mandibular Incisors.—Horizontal sections at their necks represent an ovoid figure, flattened laterally, the anterior and posterior surfaces of which are segments of a circle much smaller than that presented by the maxillary incisor teeth (Fig. 13). The blades of the instruments to be employed for their removal must therefore be narrower,

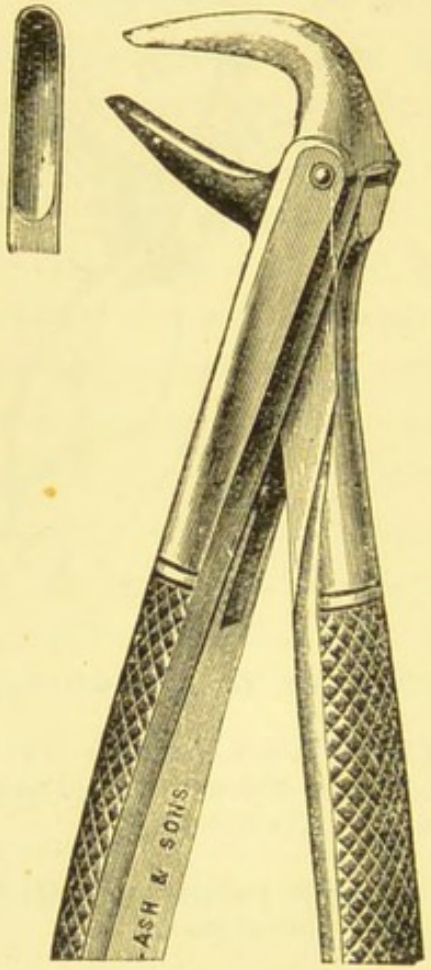


FIG. 27.—MANDIBULAR ROOT FORCEPS.

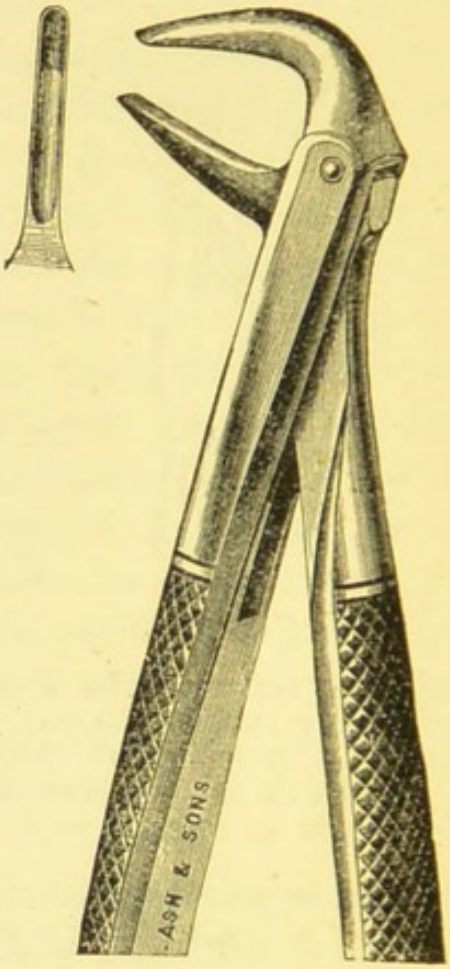


FIG. 28.—MANDIBULAR ROOT FORCEPS (FINE-BLADED).

and arcs of a smaller circle to conform to this departure. The handles should be nearly at right angles to the blades to allow their correct application and prevent the forceps from striking against the maxillary teeth while the tooth is being removed (Fig. 27).

The operator should stand on the right and slightly in

front of the patient; the alveolus is grasped on the outer and inner aspects by the thumb and first finger respectively, whilst the remaining fingers support the lower jaw. A clear view of the tooth operated upon is by this means obtained, as the thumb likewise depresses the lip and the first finger pushes aside the tongue (Fig. 29).

FIG. 29.—SHOWING POSITION OF FINGERS OF LEFT HAND FOR THE REMOVAL OF A FRONT OR LEFT MANDIBULAR TOOTH.

The instrument is pressed well down into the tooth socket, and the severing or detaching movements, which should be inward and outward, are cautiously performed. These teeth yield most readily in the outward direction, in which, combined with an upward direction, the final extractive force should be exerted.

Mandibular Canines.—The blades of the instrument should be somewhat broader for these teeth and represent segments of a larger circle; still, in practice, the same as that suitable for the incisors is found to answer very well.

The severing movements, as suggested from a sectional view of their roots (Fig. 13), must be in the same directions —viz., to and from the centre of the mouth—but they will require to be more forcible.

In removing the canines of the left side, the operator should stand almost in front of the patient, or the patient's head may be turned slightly towards the operator (Fig. 29).

The operator may take up a similar position for removing right canine teeth or stand behind the patient as in removing right premolar teeth (Fig. 30).

Roots of mandibular incisors and canines may be advantageously operated upon with forceps similar to those used when their crowns are intact, but for preference provided with slighter and sharper pointed blades (Fig. 28).

Mandibular Premolars.—Sections of these teeth at their necks present an almost circular outline, and their roots are usually conical (Figs. 13, 14). A similar instrument to the last may be employed for the extraction of these teeth (Fig. 27).

In using these forceps, which we may term the hawk's-bill or side forceps, the operator stands in front and on the right side of the patient when removing a left tooth (Fig. 29). This position is preferable to standing on the left side of the patient, as it will save the operator from changing his position when removing teeth on both sides of the jaw.

The operator stands behind and slightly to the right of the patient in removing a right mandibular premolar. His left arm passes round the patient's head, and his thumb and first finger embrace the inner and outer sides

of the alveolus respectively, the remaining fingers supporting the jaw (Fig. 30).

The forceps should be firmly pressed downwards in the direction of the tooth, and the severing process attempted by a slight rotatory movement, first in one direction and

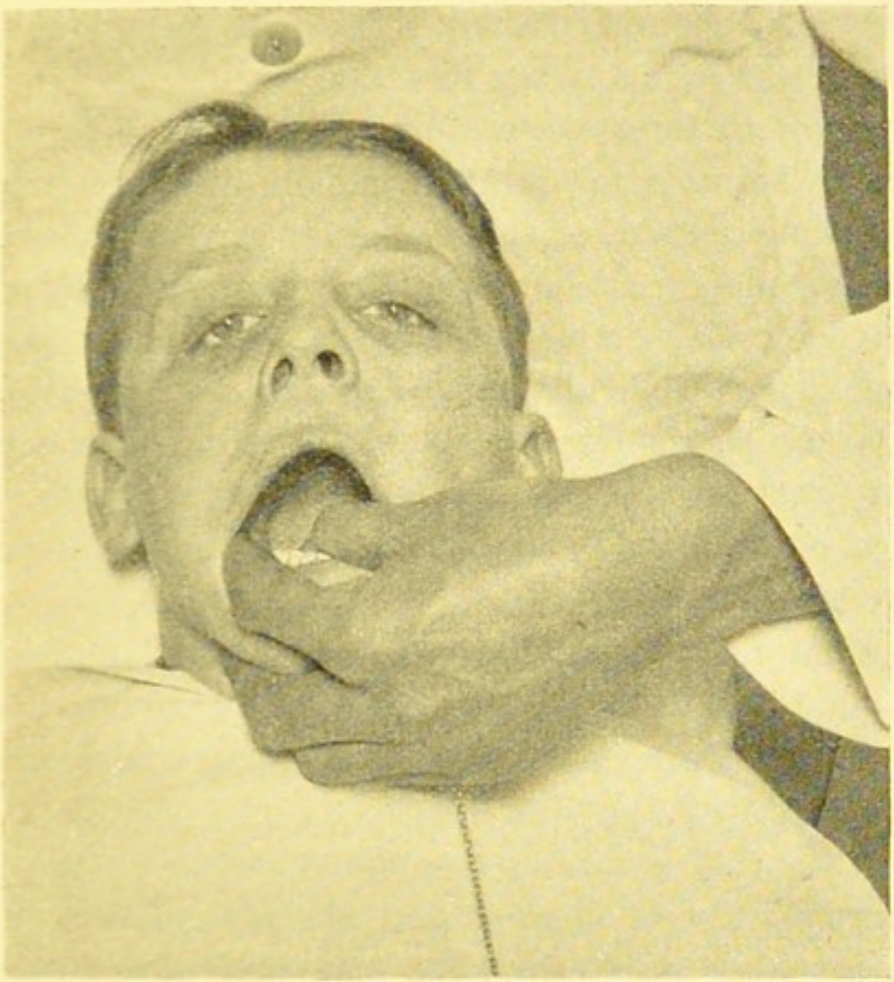


FIG. 30.—SHOWING POSITION OF FINGERS OF LEFT HAND FOR THE REMOVAL OF A RIGHT MANDIBULAR TOOTH.

Note position of operator.

then in the opposite. Anatomically these movements are adduction and abduction of the wrist-joint, combined with a slight amount of supination, pronation, extension, and flexion. It is generally advisable to commence with rotation towards the operator or abduction, if detachment be

felt after the first movements, the rotatory can be combined with slight lateral movements.

The mandibular premolars occasionally part from their surroundings with but little persuasion, yet at times offer very great resistance. We must therefore apply our rotatory force with discretion, changing it for an inward and outward one, or combining the two, rather than risk too great a force in any one direction.

The roots of these teeth, normally conical in form, and eminently suitable for rotatory movements, are liable to be curved or twisted, or to be enlarged at their extremities and thus offer resistance to their removal. When detached from their immediate surroundings, they may be dovetailed into their alveoli, and if care be not exercised, come away suddenly, causing the instrument to strike against, and perhaps damage, the maxillary teeth. This accident is more liable to occur in extraction of the mandibular molar teeth.

The same forceps may be used for mandibular premolar roots, and the same movements conveyed to the instrument, when the presenting portion of root appears fairly strong, as in dealing with the sound teeth.

When the root is carious to some extent below the gum, an instrument with slighter and sharper pointed blades will be more adaptable (Fig. 28), and some have suggested the straight elevator for such cases.

A straight or curved elevator is often the only means of removing the apices of these teeth left behind after fracture, and the reason becomes apparent when observing how often the terminal portions of these roots are curved, precluding any grasp with root forceps, even if the latter were better designed for passing deep down into the socket.

Small portions of mandibular premolar teeth often give

rise to much difficulty in their extraction, especially if the bone around be dense and the root curved, exostosed, or softened. The ordinary forms of root forceps become "locked" in the socket before reaching the root, as the socket rarely allows their blades to be opened sufficiently wide to afford a grasp of the root (Fig. 31, A). The specially

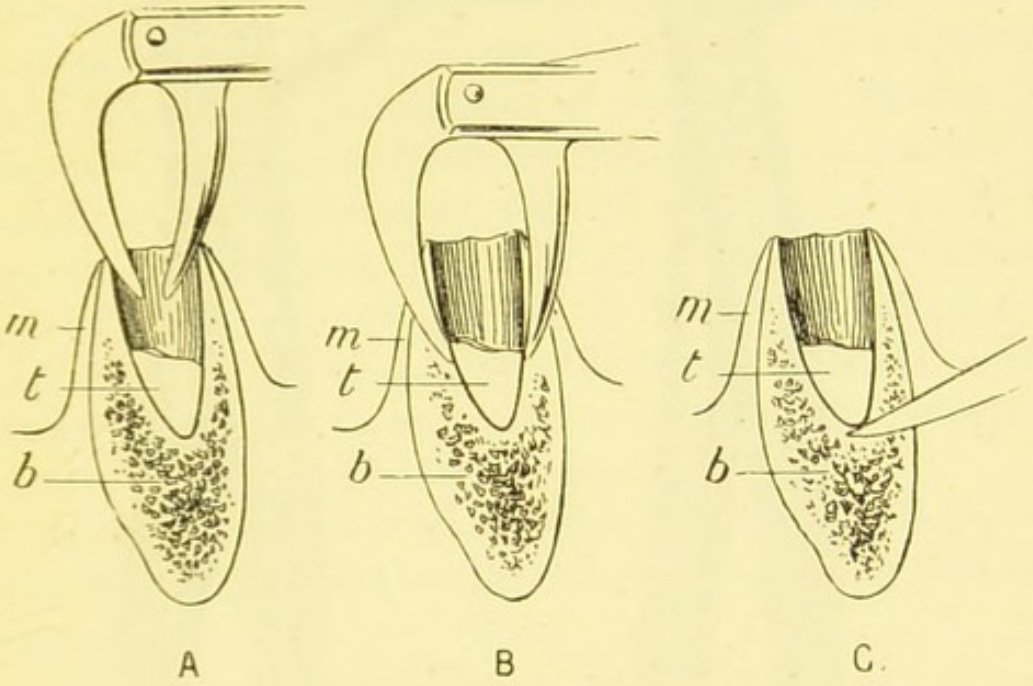


FIG. 31.

A. SHOWING HOW A DENSE SOCKET MAY PREVENT THE ADMISSION OF THE BLADES OF THE FORCEPS.
B. SHOWING THE FORCEPS INCLUDING PORTIONS OF THE ALVEOLUS IN THEIR GRASP IN ORDER TO REACH THE ROOT.
C. SHOWING THE BLADE OF A STRAIGHT ELEVATOR PASSED THROUGH THE OUTER ALVEOLAR WALL BELOW THE APEX OF THE ROOT.

t, Tooth; *m*, mucous membrane; *b*, bone.

designed instrument, with a narrow nozzle and long beak (Fig. 32), will sometimes overcome these difficulties; but a method which the author has found useful on some occasions is to thrust a straight elevator through the outer alveolar wall towards the apex of the root, and to raise the root by depressing the handle of the elevator (Fig. 31, C).

If there be a sinus on the gum, a useful guide to the apex of the root is thereby afforded, besides an indication that the bone to be penetrated is softened.

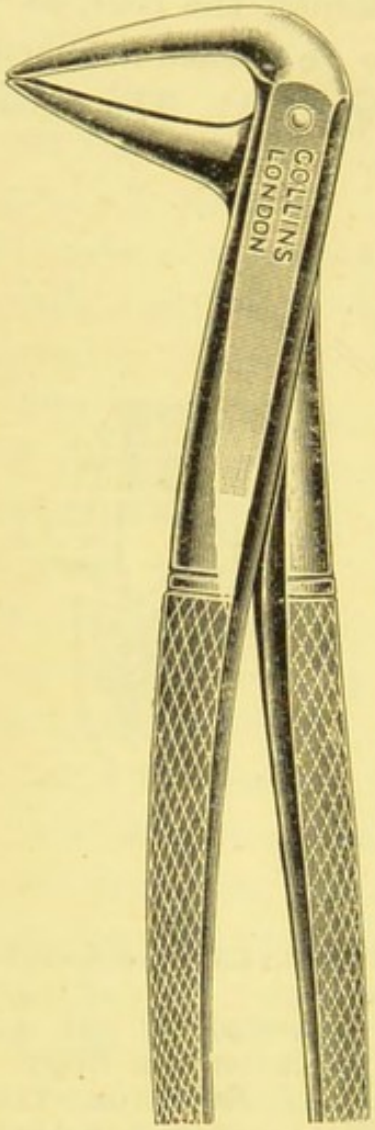


FIG. 32.—MANDIBULAR ROOT FORCEPS, DESIGNED FOR REMOVING PORTIONS OF ROOTS OF TEETH DEEP IN THE ALVEOLUS.

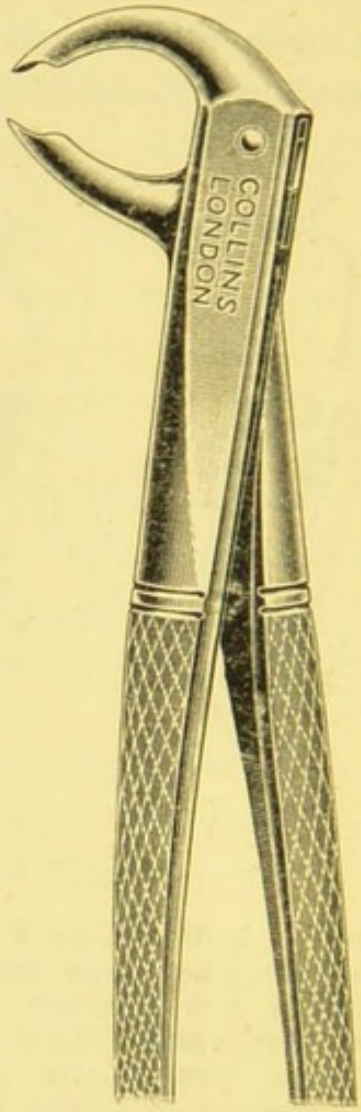


FIG. 33.—SHOWING CORRECTLY DESIGNED MANDIBULAR MOLAR FORCEPS.

Note the amount of curvature of blades.

Apart from these two methods, there may be no other means of removing these apices, unless the forceps be made to include a portion of the alveolus on either side of the root (Fig. 31, B).

The Mandibular Molars.—A horizontal section of a mandibular molar tooth at its neck (Fig. 13) shows both its external and internal surfaces to be of much the same form as the external surface of the first maxillary molar—viz., two segments of a circle touching each other at one extremity, of which the anterior segment is the larger. The blades of the instruments must, therefore, correspond in like manner; and, in order to insure the greatest accuracy, there should be an instrument for each side of the mouth. Practically, however, the difference between the sides of the tooth is so small that one instrument will suffice, provided the hinge possesses a little play (Fig. 33). This tooth has two roots placed anteriorly and posteriorly, flattened antero-posteriorly, and curved slightly backwards (Fig. 14). The anterior canal is usually flattened, and the posterior circular, in conformity with their roots.

An extra root to a molar tooth is not uncommon, especially with mandibular molars, where it is usually situated lingually.

The blades of mandibular molar forceps are usually made too concave, and so obtain only an edge grasp of the tooth, instead of following down its roots and procuring a larger surface of contact; this excessive concavity produces a blunter beak to the instrument, and thus necessitates more force in its application, and increases the chance of fracturing a frail tooth. The blades should lie nearly parallel when opened sufficiently wide to grasp the tooth (Fig. 33).

A similar fault has already been pointed out in connection with maxillary molar forceps.

The angle between the blades and handles should be nearly a right angle, so that the latter are clear of the dental arches throughout the manipulations.

For molars with hollow crowns, especially if also bulbous, a useful form of instrument is that shown in Fig. 34.

For the removal of third mandibular molars, and occasionally for the more anterior ones, when the mouth cannot be widely opened, these forceps are made with a curve in the blades to facilitate their introduction. This form of instrument is better avoided unless the extraction be a simple one, as the curved blade crosses the axis of the tooth and does not permit of correct adjustment.

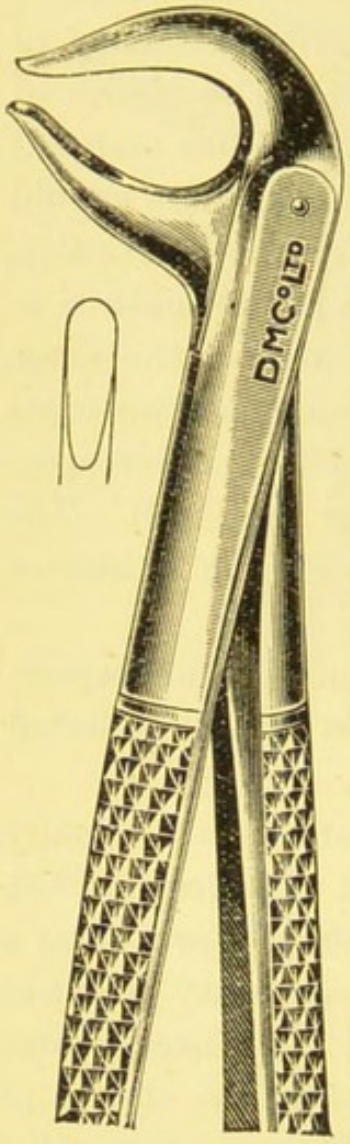


FIG. 34.—MANDIBULAR FORCEPS FOR HOLLOW-CROWNED MOLAR TEETH.

The operator should stand in the same position as that recommended for mandibular premolars, employing the left hand in the same manner (Figs. 29, 30).

Slight inward movement may first be attempted, but the tooth will generally yield more readily in the outward direction, where the alveolus is less thick.

Anatomically these movements are those of flexion and extension at the wrist-joint, accompanied with slight adduction and abduction of the arm respectively, to give a longer range of movement. A slight amount of pronation accompanies the flexion, and likewise a slight amount of supination the extension. The last movement assists in raising the tooth from its socket.

These movements do not all take place at the wrist-joint, consequently the arm is kept slightly away from the side to allow freedom for pronation and supination or for

increasing the other movements by introducing subsidiary muscles of the shoulder.

The two roots of the mandibular first molar often occupy more space than does the tooth at its crown, where it is in contact with its neighbours. To raise it vertically, without injury to the latter, would be impossible; and, where the roots are much divergent, the tooth becomes locked, necessitating the continuance of the lateral movements in order to dilate the alveolus, varied with extractive force in a direction considerably outwards.

A slight rotatory movement when the tooth is fully brought outwards will often readily disengage it from its socket.

The roots of the mandibular second molar are usually smaller and less divergent than those of the first molar (Fig. 14).

On comparing a horizontal section of a mandibular third molar, made at its neck, with a similar section of a first or second molar (Fig. 13), it will be observed that the depressions on each side marking the union of the two roots are less distinct; the blades should therefore be adapted to such forms.

Great resistance may be offered to lateral movement of these teeth owing to their backward inclination—*i.e.*, towards the angle of the jaw—a curve which is seen to increase from the first to the third molar tooth (Fig. 10). The greater such a curve is, the greater, obviously, will be the resistance to lateral movement, as a larger surface is impinged upon; also the outer alveolar plate tends to become thicker in passing from the symphysis to the base of the coronoid process. This process may be said to divide and embrace the molar and premolar regions by its external and internal oblique ridges.

The form of this curve indicates the direction in which

such a tooth will most readily yield to force—viz., upwards and backwards, towards the coronoid process.

Such a movement may be difficult to effect with the forceps, but it is the precise one which another instrument —the *elevator*—can readily effect.

The elevator consists of three portions—viz., the blade, handle, and shaft (Fig. 35).

The blade is that portion which is applied to the tooth, and some forms are constructed as if with the intention of fitting a root in its long diameter; but, as the elevator is rarely, if ever, applied in such a manner, the cuplike form which it sometimes presents is only a barrier to its effective employment.

The blade should be thin, about $\frac{1}{5}$ inch in breadth, flat, or but slightly concave on its anterior surface, and convexly rounded on its posterior surface, and from the latter to the former bevelled off and sharpened to a V-shaped point. The anterior surface may be finely grooved in its long axis; the posterior surface should be smooth, and the extremity of the instrument sharp.

The handle should be fully $3\frac{1}{2}$ inches in length, roughened, and of sufficient width to fill the palm comfortably and afford a firm grasp.

The fulness of the handle is of great importance, as a very firm grasp of the instrument is required during the rotatory movements necessary in loosening a tooth; if the handle be slender, the palm of the hand will slip round it during these movements.

The entire instrument should be made of metal, and, for preference, forged out of one piece of steel, which can be subsequently lightened by hollowing out the handle.

In operating, an elevator is used as a simple lever; it should be firmly grasped at the handle, and held somewhat like a dinner-knife, the forefinger of the right hand resting

on the blade about ½ inch from the extremity. This not only gives steadiness, but also acts as a stop or guard, should the instrument happen to slip (Fig. 38).

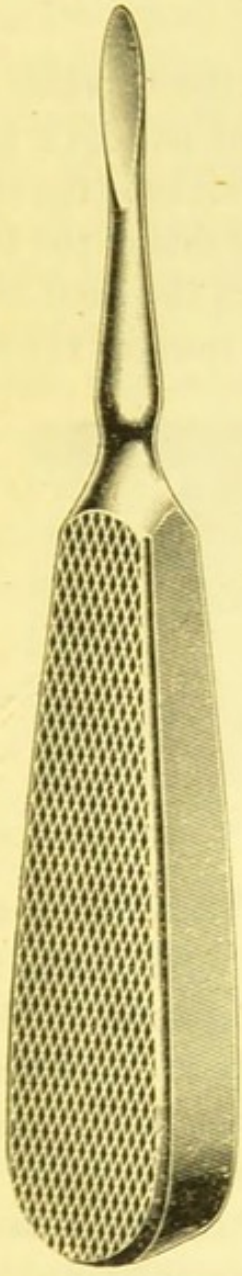


FIG. 35.—STRAIGHT ELEVATOR.

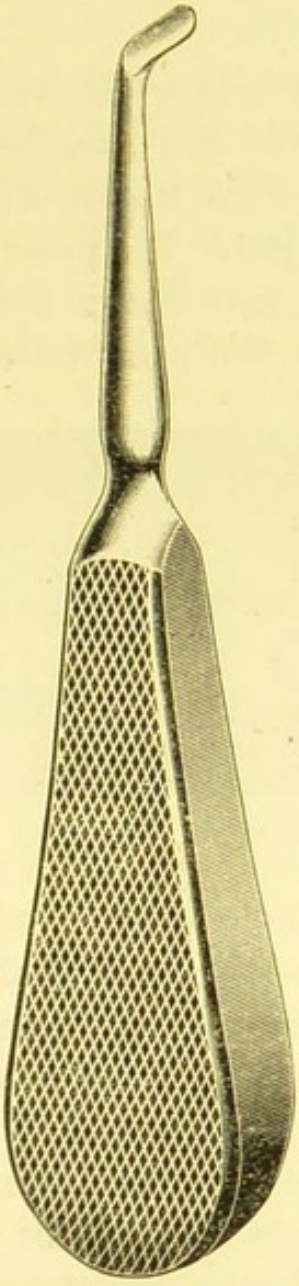


FIG. 36.—CURVED ELEVATOR.

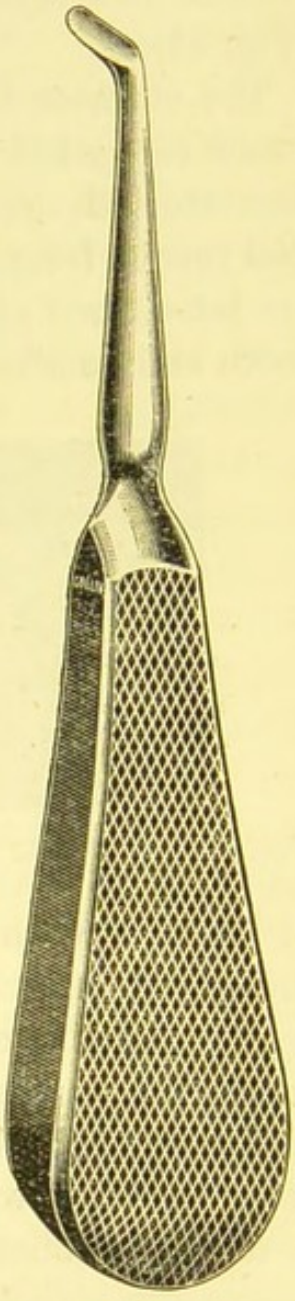


FIG. 37.—CURVED ELEVATOR.

The forefinger should be applied to the front or back of the blade, according to the side operated upon, the disengaged side of the blade and the point engaging the neck

of the tooth. If more force be required, the thumb may be brought up on to the blade in place of the forefinger.

For illustration, let us suppose that we are about to operate on a third molar of the right side of the mandible (Fig. 38).

The elevator being held as described, the operator will stand somewhat behind and lean over the patient's head, separate with the finger and thumb of the left hand the cheek and tongue from the jaw. The point and side of the blade are introduced at the gum margin between the front of the tooth and its alveolus, the point inclined towards the apex

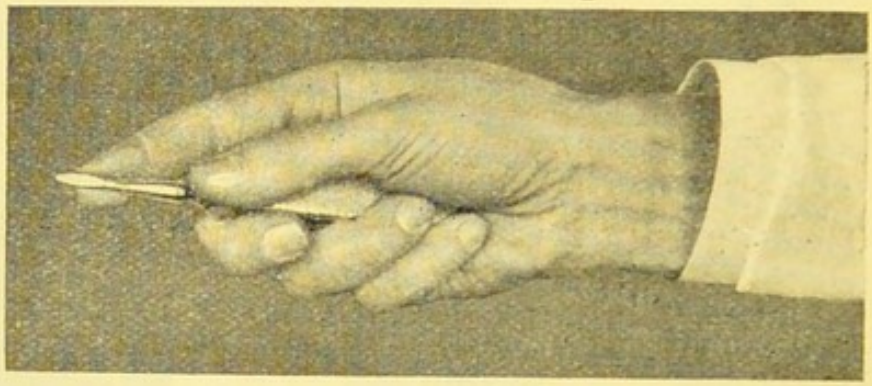


FIG. 38.—SHOWING METHOD OF GRASPING A STRAIGHT ELEVATOR.

of the root by the handle being raised. The blade is then driven well down the socket, and finally fixed into the root by the handle of the elevator being depressed. Slight rotatory movements will assist in forcing the blade down the socket by separating the alveolus from the tooth, and so allow the blade to reach further down the root.

When the blade feels fixed in the root, slight rotatory movements—*i.e.*, supination and pronation—combined with an upward one, effected by depressing the handle, will generally raise the tooth from its socket, and in the curve before mentioned—viz., that of which its crown and roots form a segment.

These rotatory movements may have to be repeated

several times, a grasp being obtained each time with the blade lower down the root.

In the final stage of the operation the force must be directed almost entirely upwards, and here every care must be taken to prevent the instrument from slipping backwards when resistance is no longer offered.

Throughout these manipulations the round part or back of the blade rests upon the margin of the socket or the neck of a contiguous tooth, either of which forms the fulcrum for the elevator or lever.

Mandibular third molars, when elevated from their sockets, will sometimes remain attached to the mucous membrane, which is firmly adherent to their necks, especially at their posterior surfaces, from which they must afterwards be detached by lancet or scissors. The elevator is employed in much the same manner for the other teeth, except that in the maxilla, and especially for single-rooted teeth, it must be introduced in a more vertical direction.

The elevator is, however, rarely required for the removal of the maxillary teeth, except occasionally for the deciduous teeth (p. 58).

The elevator should not be employed for maxillary third molars, as the force exerted may detach the tuberosity of this bone, and with it—what is more important—the hamular process of the internal pterygoid plate, possibly resulting in deafness, owing to collapse of the auditory tube from interference with the tensor palati tendon.

For detached roots, especially of the mandible, elevators having the blades set at an angle to the handles may often be employed with great advantage. These are made in pairs for either side of the mouth, and according to the position of the root (Figs. 36 and 37).

Mandibular molar roots: Roots of mandibular molars

may be found detached or united to their crowns like the maxillary molars.

When the roots are not firmly connected to the crown, root forceps are preferable to full forceps, and should be applied to the stronger and more visible root.

The ordinary movements for these teeth will frequently bring away both roots, or, if they fail to bring away more than one, the remaining root is afterwards in like manner removed.

If, after the removal of the first root, the second becomes obscured by hæmorrhage, or if previously concealed, the operation may be completed by passing a curved elevator into the empty socket, perforating the intervening septum, and raising the adjoining root. Rotatory movements, combined with depression of the handle of the elevator, will usually readily dislodge the remaining root.

If the roots of a mandibular molar be much divergent, there will be a thicker septum of bone to penetrate before the blade of the elevator comes into contact with the remaining root.

This septum of bone is generally, but not necessarily, loosened by the operation. It is sometimes easier to force the remaining root into the already empty socket by passing a curved elevator behind the root. Little resistance is offered to its movement in this direction, and the elevator can often be applied to a firmer portion of tooth.

Root forceps are preferable to the elevator when applicable, especially for the divergent roots of first mandibular molars.

The elevator may be used in a manner different from the foregoing, especially for loose deciduous roots—viz., by applying the blade firmly against them and pressing upwards, downwards, or laterally, as the case may demand.

As a general rule, if *a third or less of a healthy root* has been left behind, owing to fracture in removing a tooth,

this portion may be safely, and is perhaps better, left. Generally in these cases the end of the root is sharply curved, so that either this terminal portion of root or the alveolus must fracture, and probably the first-mentioned accident is the lesser of the two evils.

Any attempt to remove a small portion of root deep in the alveolus will not only be difficult, but accomplished only at the expense of injuring the surrounding bone If, however, there be inflammation or suppuration connected with the root, it becomes imperative to remove the root entire, or else it will continue to form a source of infection. The size of the portion left does not influence the question, as pathology pays but little respect to quantity.

The author has designed lower root forceps, which, to some extent, meet these difficulties. The blades are long and slender, and meet at their points; at the same time the width across the nozzle or beak is diminished, thus allowing the blades, when slightly separated, to be parallel and capable of being passed deeply into the socket, with but little injury to the alveolus (Fig. 32).

The diminished width of the nozzle, which is rendered possible by the absence of the crown of the tooth, has been a decided gain, as the nozzle of ordinary root forceps engages in the socket before the blade reaches the root, or before it can be opened sufficiently wide to clear its margins (Fig. 31, A).

Sometimes, by previously packing the socket with gauze or wool, the remains of a tooth can be clearly detected on a subsequent visit.

Plugging material should not be left in the mouth for more than twelve hours without being renewed, or it will become offensive, prevent healing, and possibly induce secondary hæmorrhage.

The foregoing instructions are tabulated below, and, after carefully studying the text, will be easily followed.

Teeth of Upper Jaw.

PATIENT SEATED RAISED, AND WITH HEAD SLIGHTLY EXTENDED.

Teeth.	Roots.	Forceps.	Detaching Movements.	Operator.
Incisors and canines	One conical	Fig. 6	Slight rotation, or inwards and outwards	Right side and rather in front
Premolars	One or two flattened laterally (external and internal)	Fig. 15	Inwards and outwards	Right side and rather in front
Molars, first and second	Three roots (two external, one internal)	Fig. 18	Inwards and outwards	Right side and rather in front
Molars, third	Three roots (two external, one internal; often agglutinated)	Figs. 18, 19	Inwards and outwards	Right side and rather in front

Teeth of Lower Jaw.

PATIENT SEATED AT ORDINARY HEIGHT, HEAD IN VERTICAL POSITION.

Teeth.	Roots.	Forceps.	Detaching Movements.	Operator.
Incisors and canines	One, flattened laterally	Fig. 27	Inwards and outwards	Almost directly in front
Premolars	One conical	Fig. 27	Slight rotation, or inwards and outwards	Behind for right side, in front for left
Molars, first and second	Two (anterior and posterior)	Fig. 33	Inwards and outwards	Same as for premolars
Molars, third	Two (anterior and posterior, often agglutinated)	Fig. 33	Inwards and outwards	As above

Extraction of the Deciduous Teeth.

The deciduous teeth are distinguishable from their successors by their smaller size, lighter and more transparent colour, and by the enamel terminating in an abrupt ridge at the gum margin, and so accentuating their neck. The masticating surfaces may exhibit evidences of wear, and the teeth themselves be slightly loose, and spaced at an age when they might be mistaken for their successors. Their position and relation to other teeth in the dental arch would further serve to indicate their nature (Figs. 39, 40).

Deciduous incisors and canines are relatively broader and shorter than their successors.

Maxillary first deciduous molars have three cusps, two external and one internal, thus differing from the square four-cusped crown of a permanent molar (Fig. 40).

The indications for the removal of the deciduous teeth are somewhat different from those of the permanent series, owing to the following circumstances:

1. The deciduous teeth are only subservient for a short, although important, period during life.

2. The age of the patient during which the deciduous teeth are functional.

3. The fact that these teeth are to be followed by "permanent" ones, whose position, usefulness, and soundness depend to some extent on their predecessors.

4. The fact that the growth of the jaws and of the body generally is most active during the time at which the deciduous teeth are functional, and that this growth is to some extent dependent on their presence, and influenced, favourably or unfavourably, by their condition.

5. The diseases requiring removal of teeth for their cure or alleviation are somewhat different in the earlier and later periods of life.

Bearing the above circumstances in view, the following would be considered some of the main *indications* for the removal of the deciduous teeth:

1. Deciduous teeth which have become so loose as to be not only useless, but annoying to the tongue and cheek, and liable to be dislodged at any time.

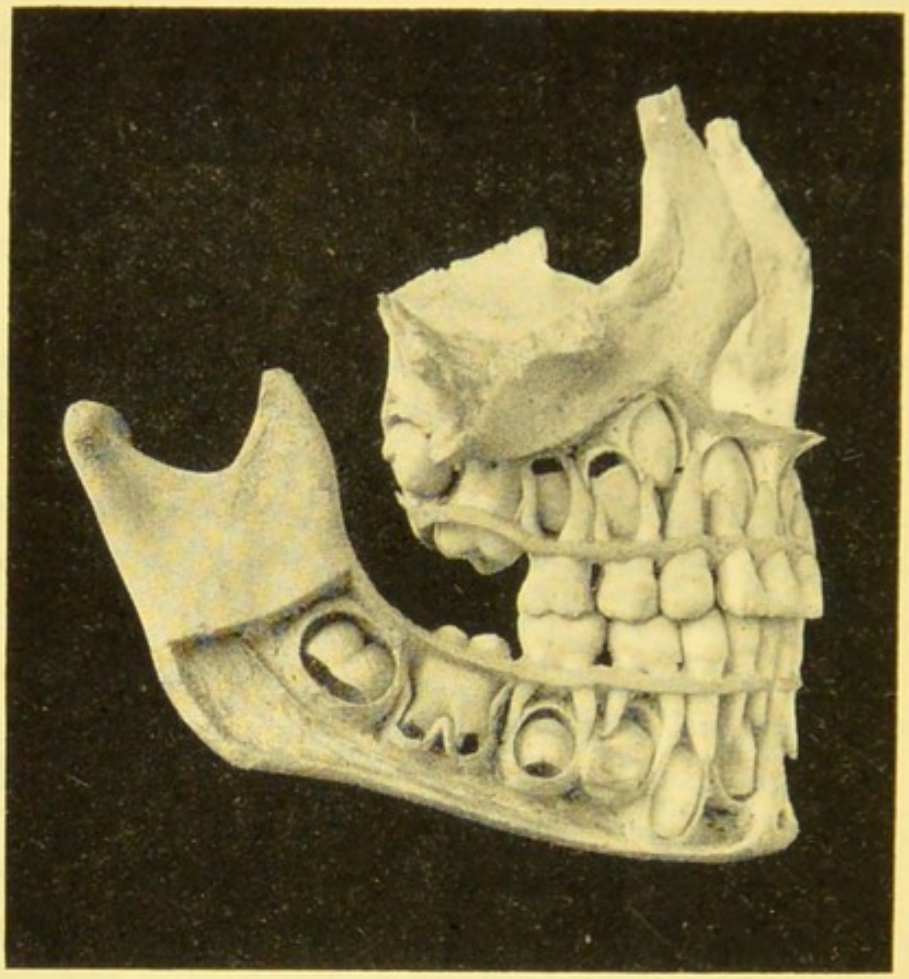


FIG. 39.—SHOWING THE DECIDUOUS TEETH IN OCCLUSION, AND THEIR PERMANENT SUCCESSORS LYING IN THEIR CRYPTS.

Note the relation of the two dentitions to each other. (From "The Science and Practice of Dental Surgery.")

2. Deciduous teeth require removal when they are impeding the eruption of their permanent successors, or causing the latter to deviate from their normal position.

3. Carious or injured deciduous teeth giving rise to

pain or subjecting their successors to the liability of caries at a time when their functional period is, or should be, nearly at an end.

4. When the saving of an aching tooth would require a long and tedious operation in a fretful and nervous child, and when the child's health has evidently suffered from sleepless nights.

5. Deciduous teeth causing or aggravating inflammation, suppuration, ulceration, necrosis, or other pathological

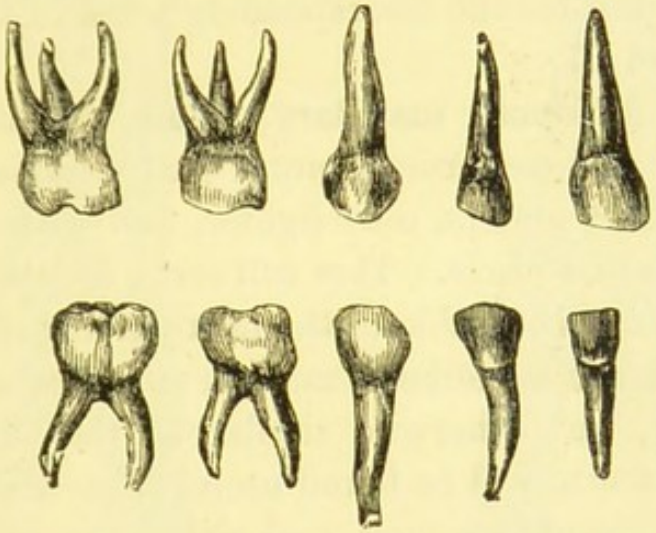


FIG. 40.—DECIDUOUS TEETH OF RIGHT MAXILLA AND MANDIBLE.

a, Central incisors; *b*, lateral incisors; *c*, canines; *d*, *e*, molars.

lesions of the adjoining soft or hard tissues, when the tooth or teeth in question are not readily amenable to other treatment.

6. Deciduous teeth apparently the cause of enlargement of the lymph-glands, or where such teeth act possibly as a source of irritation to already diseased lymphatic tissue.

The cervical lymph-glands in young children may be palpable without necessarily being diseased, as there is a hyperplasia of lymph-tissue in early childhood, but soften-

ing of their structure or tenderness on palpation should be regarded with suspicion.

Extraction of the deciduous teeth will be conducted upon precisely the same principles as for the permanent ones, except that instruments on a smaller scale are preferable, and fewer will be necessary.

Deciduous Incisors and Canines.—A pair of small incisor forceps will suffice for the removal of these teeth in the maxilla, and an instrument similar to that used for the permanent teeth, only lighter and with shorter and more slender blades, for the corresponding teeth of the mandible (Figs. 7 and 27).

For the **deciduous maxillary molars**, an instrument is required that is constructed much on the same plan as for the permanent molars, only lighter, and with both blades as segments of a circle. This will serve for the removal of these teeth on either side of the maxilla (Fig. 41).

For **deciduous mandibular molars**, an instrument, smaller and lighter, but otherwise similar to that used for the permanent teeth, will be found useful (Fig. 42).

The first deciduous molars of either jaw can, however, be conveniently removed with root forceps, and the second deciduous molars with their respective permanent molar forceps.

A pair of fine upper and lower root forceps forms a useful addition, especially for the separated roots of molar teeth, where, if too broad a blade be used, there is a danger of encroaching upon the erupting premolars, and either chipping their crowns or loosening them (Figs. 24 and 28). The position of the patient and operator will be the same as that detailed for the permanent teeth.

The movements of seizing, loosening, and removing the tooth will be the same as for the corresponding permanent teeth, but *less force* will be necessary.

Incisors and canines, both upper and lower, are generally removed without much difficulty. They occasionally yield with a snap, strongly suggesting a fracture of their root, but due in reality to their attachment to the surrounding bone. Their roots are more or less ab-

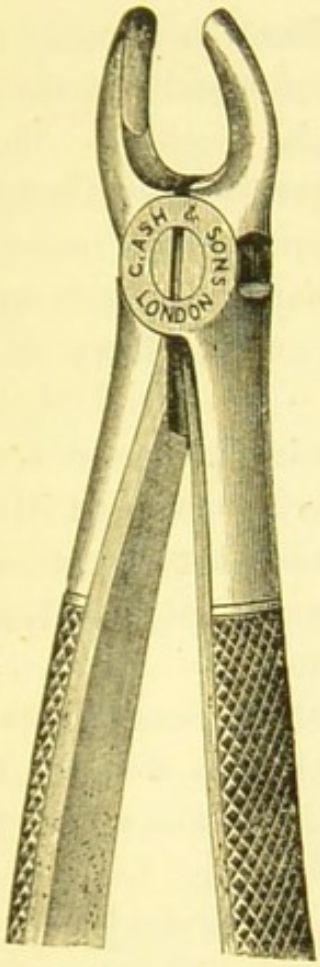


FIG. 41.—DECIDUOUS MAXILLARY MOLAR FORCEPS.

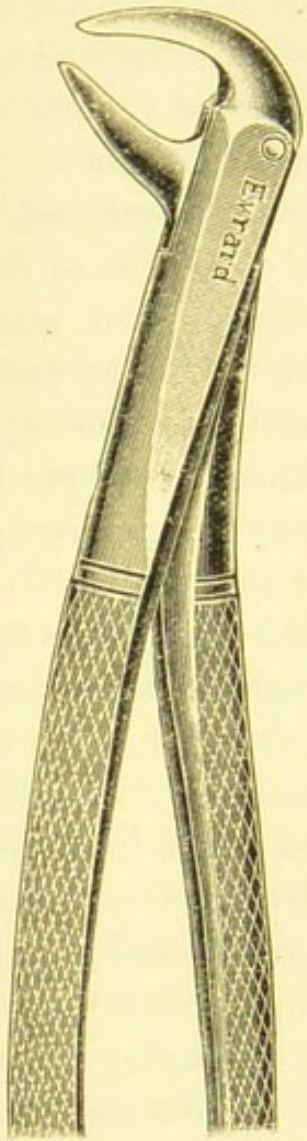


FIG. 42.—DECIDUOUS MANDIBULAR MOLAR FORCEPS.

sorbed according to the period of removal, the position of their successors, and the condition of the teeth themselves — viz., whether containing live or dead pulps.

When the roots of deciduous teeth become necrosed through gangrene of their pulp, they frequently give rise to

ulceration of the overlying tissues, and protrude, with a greater or less extent of their root exposed.

The ulceration of the gum is probably due to the presence of the necrosed root acting as a foreign body, as the ulceration is limited to this region. The sequestration of the necrosed root is hastened by the pressure exerted on it by its successor.

These exposed deciduous roots almost invariably present on the outer side of the alveolus, and usually in the maxillary incisor and mandibular molar regions. They are easily removed by passing a straight elevator between the root and gum and applying pressure in the line of least resistance. If there be a thick band of overlying gum, this may be previously divided by cutting down on to the root with a scalpel.

Deciduous molars are the teeth in this series requiring most care in their removal, as, having fine and divergent roots, they are liable to be fractured unless the movements are cautiously made, and their range only gradually increased as the tooth becomes loosened.

A deciduous molar root can usually be easily picked out with fine-bladed root forceps, or with an elevator, applied close up against the root, so as to avoid the risk of loosening or dislodging the underlying premolar.

A deciduous root need rarely be left in the jaw if a suitable instrument be at hand, and its presence may prevent a permanent successor from assuming its correct position.

The removal of deciduous roots, after their successors have taken up their alignment, may require great care, and instruments such as excavators, enamel chisels, or a small Volkmann's spoon, may be of more service than forceps.

A deciduous tooth that has retained its position in the dental arch beyond the normal period but not to the exclusion of its successor should on no account be removed,

or a permanent gap may be left, which might otherwise have been filled by this substitute for many years. The roots of a deciduous tooth are not usually absorbed in the absence of its successor.

Whether the removal of a deciduous tooth will favour the eruption of its successor in the absence of mechanical difficulties is open to doubt, as one would expect that the permanent tooth itself could overcome the usual physiological conditions of eruption.

A *set of instruments* comprising six pairs of forceps, three elevators, a blunt probe, conveying tweezers, and a mouth mirror, would be all the requirements for most cases of extraction (Fig. 43).

The forceps should consist of the following: Upper molar forceps (right and left), lower molar forceps, upper and lower incisor forceps, upper curved root forceps, elevators (straight and curved).

Upper incisor forceps will be convenient for incisors, canines, and their respective roots (Fig. 43 [1]).

Lower incisor forceps for incisors, canines, premolars, and their roots, and the roots of molars (Fig. 43 [2]).

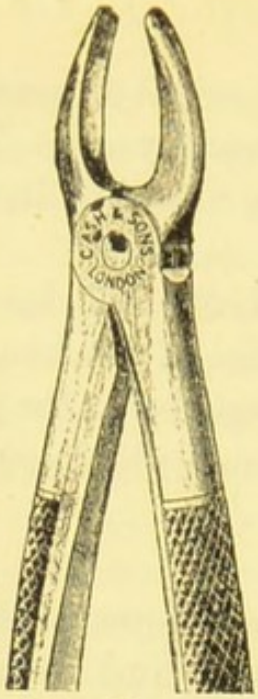
Upper curved forceps for premolars, molars, and their roots (Fig. 43 [3]).

Upper molar forceps for molar teeth, one pair for each side (Fig. 43 [4]).

Lower molar forceps for molar teeth of either side (Fig. 43 [5]).

Elevators, two curved and one straight pattern, chiefly for the roots of mandibular molar teeth and third mandibular molars, but occasionally for other purposes, as already mentioned (Fig. 43 [6] and [7]).

A blunt probe is necessary for defining the margins of roots, or determining their presence or absence.



(Fig. 6. p. 15)

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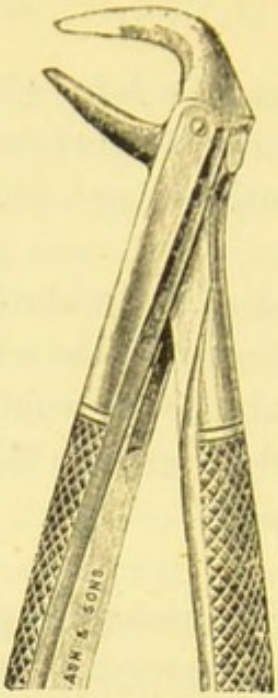

(Fig. 27. p. 36)

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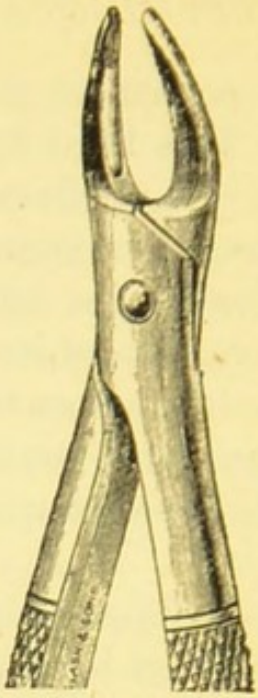

(Fig. 23. p. 32.)

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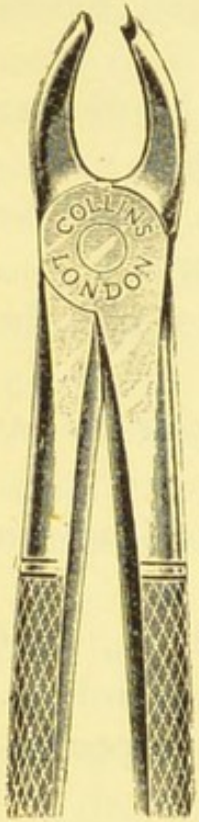

(Fig. 18. p. 28)

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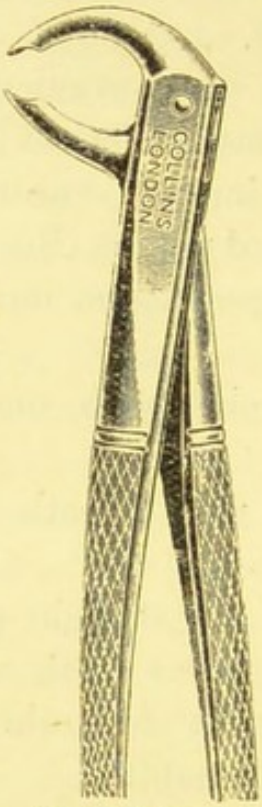

(Fig. 33. p. 42)

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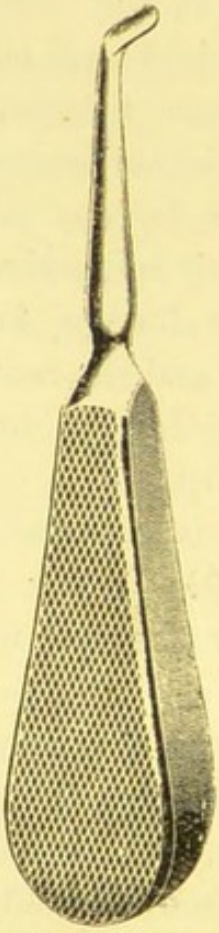

(Fig. 36. p. 47)

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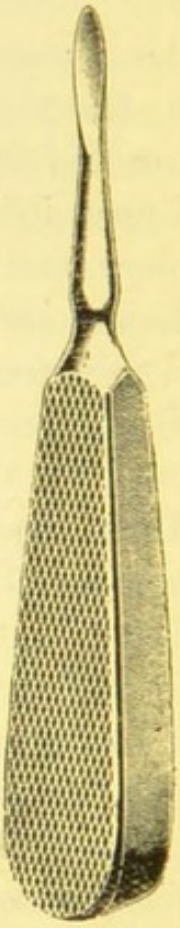

(Fig. 35 p. 47)

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FIG. 43.—SHOWING A SET OF INSTRUMENTS.

The above forceps may be well used for similar teeth in the deciduous series, employing, for preference, root forceps for the first deciduous molars.

Teeth may be erupted at or even prior to birth. These early teeth may be well formed or consist of but little more than a sharp calcified cusp, loosely attached to the mucous membrane, and can, in most cases where necessary, be removed with the fingers.

CHAPTER II

DIFFICULTIES, COMPLICATIONS, AND SEQUELÆ OF TOOTH EXTRACTION

Difficulties of Tooth Extraction.

A COMMON difficulty is great **resistance of the tooth**, and judgment as well as skill will be taxed in deciding how much force may be lawfully employed.

We may expect to find teeth of a yellowish shade, and somewhat worn on their crowns—especially in persons about middle age, and of " wiry " constitution—more difficult to remove than large, light-coloured teeth in younger persons. The size of the crown of the tooth is no criterion as to the firmness of the roots.

A first or second molar of either jaw standing alone or a maxillary canine will often prove unusually hard to remove. Our judgment will often be severely taxed in such cases; but it may be well laid down as a rule that the practitioner, especially if a strong man, should never expend the whole of his strength on any tooth. The amount necessary to be exerted may be great, but must be restricted within limits. It is extremely unpleasant to send a patient away with an aching tooth *in situ*, but frequently there is a cessation of pain in a tooth the removal of which has been attempted; and should the patient be seen a day or two later, the tooth will, in all probability, have become slightly loosened by inflammation set up as a result of the pre-

vious attempt at extraction, and yield to a moderate amount of force.

As it is more desirable to complete the operation at the same visit, both from the patient's and practitioner's point of view, it will be advisable to obtain an anæsthesia which can be prolonged for several minutes if found necessary, and then to apply once more our force with care and judgment, firmly supporting the alveolus on either side.

These resistant molar teeth generally present but little caries, and in the first attempt at their removal full forceps are naturally utilized. However, if root forceps are passed well up the socket, obtaining a secure grasp on one or two roots, according to the tooth in question, successful removal will frequently be effected; or, if fracture should occur, it will be more likely a separation of the tooth into its component roots than a transverse fracture across these. If the former, the remaining root or roots are easily removed, whereas the latter may be a very troublesome condition to remedy if the fracture is low down in the socket.

Full molar forceps are not well adapted for obtaining a firm grasp on the roots of teeth, although they embrace a larger portion of tooth substance than root forceps.

Forceps have been devised for splitting up a molar tooth into its component roots, each of which can be separately removed (Figs. 22 and 44). These may be found useful when dealing with resistant teeth, especially if exostosis or divergent roots be suspected as the cause; but the same result is usually attained with root forceps. Pathological conditions may be associated with the roots of teeth, which preclude their removal by the ordinary methods—*e.g.*, dilaceration, a result of injury to a tooth-germ and odontomata.

The causes of great resistance in the removal of a tooth are partly in the conformation of the tooth—*e.g.*, the form

and direction of its roots—and partly in that of the surrounding bone—*e.g.*, where this is thick and dense, as sometimes found around an isolated mandibular molar.

Occasionally a tooth may be slightly loosened in its socket without using much force, but yet will resist further efforts in its removal. In such teeth the roots may be long and curved or clubbed and thickened from exostosis. If the exostosis only amounts to slight thickening, by repeating the movements suitable for loosening the tooth the socket will be dilated sufficiently to allow of delivery of its roots.

In some cases it may be necessary to gouge away the overlying bone to remove an enlarged or distorted root.

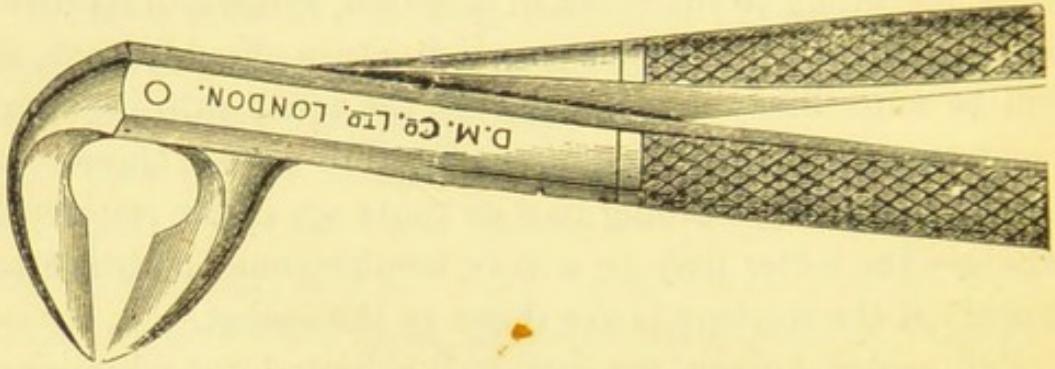

FIG. 44.—SPLITTING FORCEPS FOR MANDIBULAR MOLARS.

A molar tooth firmly implanted in the jaw, but yet standing well out above the gum margin, may offer difficulties to its extraction, chiefly owing to want of adaptability of ordinary forceps.

If full molar forceps be used, these impinge on the crown before the blades are sufficiently below the gum to insure a firm hold, so that the strain comes on an unsupported portion of tooth with liability of fracture; whereas if root forceps be employed, the amount of tooth substance within the grasp of the blades is less, and so the strain on any one part is greater, likewise increasing the risk of fracture. The exposed divergent roots of these teeth afford very little grasp to the forceps usually employed. The palatine root

is usually the more divergent, so that the force should be at first directed inwards, as there is some liability of the instrument slipping off the root when moved in the opposite direction.

Teeth may, owing to **abnormal formation of the crown**, be rendered difficult to remove, no ordinary instrument being capable of adaptation to them; and the position assumed by teeth in regard to their neighbours may wholly prevent the employment of the ordinary instruments, or, at all events, in the usual direction.

This condition, the result of **crowding of the teeth,** is not infrequently met with in the mandibular incisor region.

Misplaced Incisor Teeth.—A mandibular incisor may be placed so directly before or behind the other teeth that there is insufficient space for the application of the posterior or the anterior blade respectively. To meet such cases, forceps having a narrow posterior or a narrow anterior blade are constructed (Figs. 45 and 46); but, as these narrow blades are apt to nip off the crown or split the root, it is often preferable to employ the ordinary root forceps and grasp the tooth laterally. The blades must be pressed well towards the alveolus, or they will slip off the tooth.

For the corresponding condition in the maxilla the same remarks apply, but only one instrument is required, as the forceps are capable of being reversed (Fig. 47).

Misplaced Maxillary Canines.—These teeth are commonly misplaced outside the arch, and as a remedy their removal may be required.

The blades of the forceps are best applied laterally to the tooth—*i.e.*, on their mesial and distal surfaces—being guided into this position by the finger and thumb placed on either side of the tooth. As a rule these teeth have straight roots, and yield readily to slight rotatory movements, especially as the outer alveolar plate is so thin that the root can be

frequently traced along its whole length and over a large portion of its circumference.

The maxillary canine, as well as being placed outside the arch, may lie obliquely, or even assume a horizontal position. In the latter case the removal can be best effected

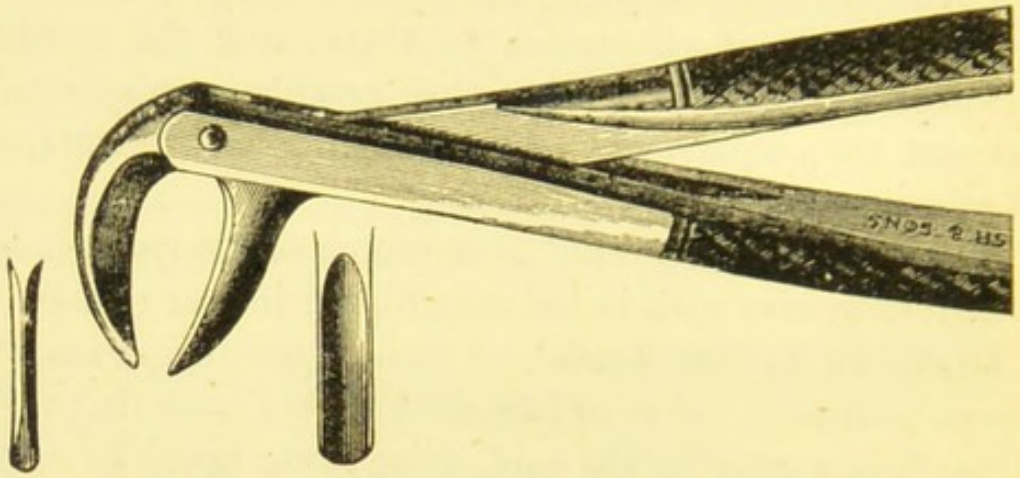

FIG. 45.—MANDIBULAR FORCEPS WITH NARROW POSTERIOR BLADE.

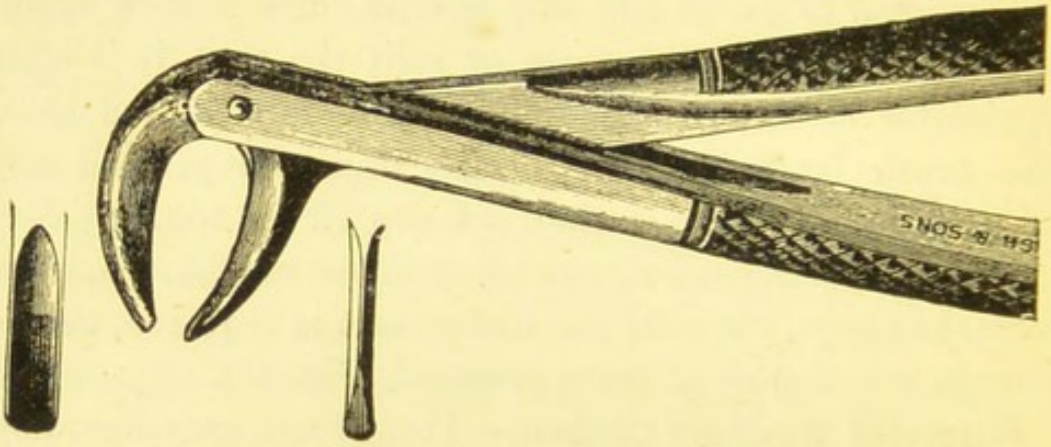

FIG. 46.—MANDIBULAR FORCEPS WITH NARROW ANTERIOR BLADE.

with an elevator, previously incising the gum and gouging away the overlying bone, if this should be of any thickness.

Maxillary canines are less frequently placed inside the arch. This misplacement of the canines may necessitate their removal if they interfere with the comfort of the tongue or predispose to caries in other teeth.

Maxillary canines so placed generally have distorted roots, and no rule can be laid down as to the best means for their removal, except that all movements must be made cautiously, and in what appears to be the line of least resistance, commencing with slight lateral movements to determine this point. Their roots sometimes pass between those of the incisors.

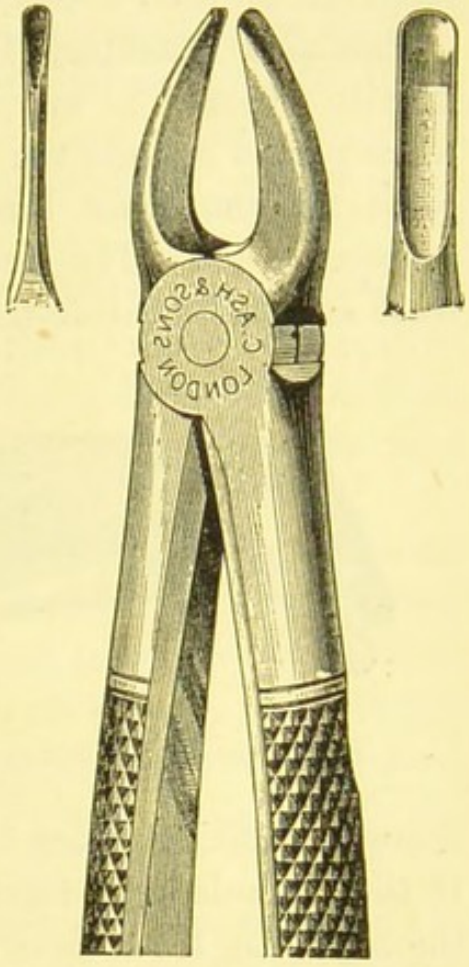

FIG. 47.—MAXILLARY FORCEPS WITH BLADES OF UNEVEN WIDTH.

Misplaced Mandibular Canines.—These may be difficult teeth to remove when situated outside the arch, but, fortunately, seldom require removal on this account alone. These teeth, having flattened roots, do not admit of rotatory movements, so that a lateral grasp will not be a favourable one for their removal. The blades should, if possible, be applied to their inner and outer surfaces, the inner blade being fine in order to pass between the adjacent teeth, and the lateral movements should be conveyed almost entirely in an outward direction, to avoid impinging against the adjoining teeth.

Mandibular canines placed inside the arch are usually troublesome teeth to extract owing to the difficulty in adapting the forceps to the tooth, or, when adapted, in preventing the mandibular incisor teeth becoming loosened during the manipulations.

Occasionally these teeth present in the floor of the mouth, near the frænum of the tongue.

Upper curved root forceps, or lower straight forceps (Figs. 23, 48), are often the best adapted to such a position, and a lateral grasp will be less likely to damage the incisor teeth during their removal.

Misplaced Maxillary Premolars.—These teeth do not usually give rise to any special difficulty in their removal when placed outside the arch, provided there be sufficient room for the inner blade of the forceps between the adjacent teeth. The same statement applies when these teeth are placed inside the arch, provided, in this case, that

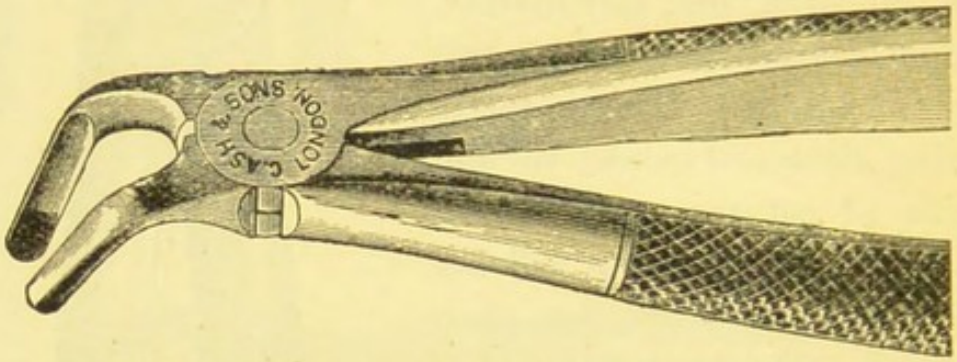

Fig. 48.—Mandibular Forceps (Straight Pattern).

there be sufficient space for the outer blade of the forceps. If the premolars be further displaced either way so that the adjoining teeth have come together, the blades of the forceps must be applied to the mesial and distal surfaces of the tooth, and the movements made as far as possible in the usual directions.

Misplaced Mandibular Premolars.—If these present outside the arch, as a rule not much difficulty arises in their removal, as, having conical roots adapted to rotatory movements, they may be so removed by means of a firm grasp anywhere around their circumference. When displaced inside the arch, with their crowns directed towards the tongue, they may be difficult teeth to remove, and upper

curved root forceps or lower straight forceps may be required (Figs. 23, 48), according to the amount of inward displacement, the latter instrument being useful if there be much displacement, or when the crown is directed markedly inwards.

Whether grasped laterally or antero-posteriorly—*i.e.*, on mesial and distal surfaces—the movements must be first those of rotation and then slight lateral movements, if the adjacent teeth will permit. If the displacement inwards be slight, lower premolar forceps having a narrow outer blade may suffice.

Mandibular premolar teeth are frequently twisted on their axis, so that the buccal surface looks backwards as well as outwards. Beyond causing a little awkwardness in the application of the forceps, no further trouble need be anticipated by this derangement.

Misplaced Maxillary Molars.—Maxillary third molars are not infrequently placed outside the dental arch, and may assume a position directly external to the second molars. Misplaced maxillary third molars do not usually give rise to much difficulty in their removal, as the teeth are small, the roots are generally short and agglutinated, and the surrounding bone is porous.

They are occasionally fused with the second molars or with a supernumerary tooth. This union is frequently below the gum-level, and may not be detected unless explored with a probe. Fusion may be suspected when the third molar assumes an abnormal position, so that in removing the misplaced molar, or the supernumerary tooth, the adjacent teeth must be carefully watched to see that they remain firm during the extractive movements.

Misplaced Mandibular Molars.—The molar teeth most liable to be misplaced are the third molars, and more especially those of the mandible. The misplacement of these

teeth is due to their eruption after the other teeth have assumed their position in the dental arch, so that, should insufficient space remain, it is the third molars which must accommodate themselves to some other position or remain unerupted. Again, these teeth, being developed deep in the substance of the jaw, are more liable during their growth to meet with some obstruction which diverts them from their normal course. Further, the third molars, being retrograde teeth tending to suppression, are, like all organs of the body in this condition, liable to faulty development, resulting in abnormalities in shape, position, and structure.

Mandibular third molars may be arrested in their eruption or erupt in abnormal positions through want of space, and in either case give rise to difficulty in their removal.

Misplacement generally occurs outside the dental arch. These teeth have sometimes erupted on the ascending and horizontal rami of the mandible, with their crowns appearing through the skin. In fact, mandibular third molars may erupt or remain embedded in the neighbourhood of their development or in any direction radiating from this.

The difficulty in removing misplaced mandibular third molars lies partly in their inaccessible position, and partly in the frequently concomitant swelling of the surrounding parts, which, infiltrating the masseteric and pterygoid regions, gives rise to partial or complete **closure of the jaws (trismus)**.

If insufficient space or inaccessibility of position renders the use of forceps difficult, a straight elevator is often a valuable instrument for removing these teeth.

Fortunately, the tooth is generally slightly loose when it has caused sufficient swelling to produce trismus, and the surrounding tissues are soft and yielding as the result of the inflammation.

When closure of the jaws is complete, and it is difficult

to insert the blade of an elevator between the alveolus and the front of the tooth, the blade may be forced down the buccal or outer side of the socket, and, the margin of the alveolus being used as a fulcrum, the tooth is prised up from its socket, care being taken in so doing that it is not dislodged into the buccal cavity, as under these conditions its removal would be troublesome or dangerous if the patient be under an anæsthetic.

This method allows a better view, as the blade of the instrument is not in a line with the tooth operated on. Frequently it is advantageous to commence the process in this way, and when the tooth is felt to be slightly loosened, the operation may be continued by using the elevator in the ordinary manner.

In either case, when the tooth is once loose, its actual removal from the mouth is completed as much with the finger as with the elevator—in fact, generally by using the two together.

An elevator has been devised for these cases having a short blade, somewhat resembling a single jaw of a pair of root forceps, which passes off at an angle (about 45°) to the shaft of the instrument; while the blade engages the front of the tooth, the handle assumes a horizontal position to the outer side of the dental arch (Fig. 49). The movements for loosening the tooth are almost entirely rotatory, and where the front wall of the tooth is fairly sound this elevator is a convenient instrument, but being incapable of affording a grasp low down on the root, its use is consequently limited to fairly strong teeth.

The use of a straight elevator is sometimes precluded by the tautness of the cheeks, and in such cases the above instrument is most serviceable.

When mandibular third molars are carious or fractured below the alveolar margin, and from their inaccessibility

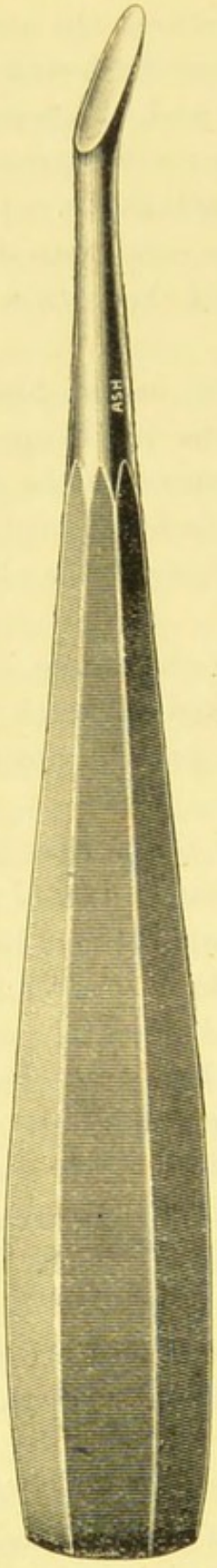

FIG. 49.—THE BENT ELEVATOR.

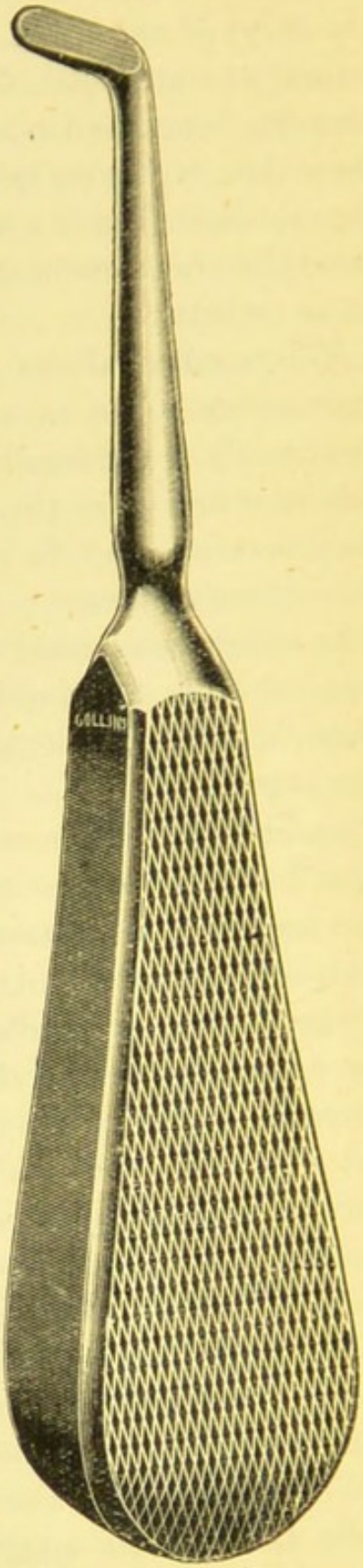

FIG. 50.—THE RIGHT-ANGLED ELEVATOR.

lower root forceps are not applicable, there is no instrument which satisfactorily meets the condition. Elevators do not obtain a sufficiently low grasp on the root, even if they reach the latter, and these instruments can rarely grip a root below the level of the alveolus.

To overcome this difficulty, the author constructed an instrument in which the blade is set nearly at a right angle to the shaft, so that, when applied to the front of a lower wisdom tooth, the whole surface of the blade can be brought into contact with the root. The blade is wedge-shaped and pointed—in fact, devised so as to pass down the socket between the anterior root of the tooth and its alveolus (Fig. 50).

If an anæsthetic be administered, the mouth can be gradually opened with a gag, starting, whenever possible, by the insertion of a small prop, so as to economize the period of anæsthesia, and for the safety of the patient should breathing cease.

Frequently the mouth can be well opened under anæsthesia, and the operation thereby much simplified.

Mandibular third molars may require removal when they become **impacted,** or are from any other reason prevented from erupting, and so causing trouble to the adjacent teeth, bone, and soft tissues.

The most usual cause for impaction is insufficient space between the molar in front and the base of the coronoid process behind. The tooth may be covered with a layer of bone, or one or more cusps—generally the anterior ones—may have erupted, while the rest of the tooth remains embedded in bone.

Impacted mandibular molars can usually be removed with forceps, provided the covering bone is thin, and some indication of the position of the tooth is afforded. The blades of the forceps are widely opened, and driven

down to the hilt in the opened position, and only cautiously closed when they are felt to embrace the crown of the tooth. Slight lateral and rotatory movements are then applied, bearing in mind the markedly backward curve that these teeth often possess. Full molar forceps can be employed if the crown of the tooth is discernible through the gum, otherwise strong root forceps will obtain a deeper reach. It may be necessary to embed the entire beak of the instrument before a grip on the tooth is obtained, and the forceps must be firmly retained in this position while loosening the tooth. Most third molars that can be removed with an elevator can be removed equally well with forceps. If the tooth be rotated or otherwise lie in such a position that a grasp with forceps is unattainable, the overlying bone must be removed before the tooth can be raised.

When the tooth is deeply embedded in the jaw, it will be necessary to gouge away some of the bone to expose a portion of the tooth, which can be then dislodged by means of an elevator or scoop. This procedure is rarely necessary, as if the tooth be deeply embedded in the jaw it seldom gives rise to discomfort.

The extraction of a sound mandibular second molar, as a preliminary to the removal of an impacted third molar, can rarely be necessary or justifiable, although it may undoubtedly simplify the operation.

It is sometimes desirable to remove **unerupted premolars** to remedy a crowded mouth, or where the latter condition is anticipated.

The deciduous predecessors are first removed, and root forceps are then passed well down the socket until the permanent tooth is included in their grasp. The blades of the forceps should be opened sufficiently wide to include the premolar crown and as much of its root as possible.

Rotatory and lateral movements readily loosen the tooth, the roots of which are usually incompletely formed.

Root forceps may be used for the removal of the first deciduous molar and its successor, thus obviating a change of instruments.

In dealing with misplaced teeth, a good deal of information may be obtained by radiography. Their position, direction, and relation to other teeth may be elucidated, or the presence or absence of teeth determined.

Supernumerary teeth occur most often in the maxillary incisor region, less frequently in the maxillary third molar region, and these may require removal when causing irregularity of other teeth, or if deformed and carious.

They are almost invariably single-rooted, but frequently distorted, and on this account require care in their removal.

Complications and Sequelæ of Tooth Extraction.

During the removal of a tooth in a young person, **a neighbouring tooth may be loosened or removed,** if care and precaution are not exercised. In such cases the adjoining tooth will be generally seen to move with the one operated on. When this occurs, the operator should firmly press with the left finger or thumb upon the crown of the tooth in danger, and should, in using the forceps or elevator, not apply more force than can be controlled by the finger or thumb until a severance is felt, when the removal may be safely accomplished.

Should an adjoining tooth be partially or entirely removed from its socket, it should be immediately reinstated by firmly pressing it into its place, when it will most probably again become united to its membranes, and be as serviceable as before.

In removing teeth of young persons with the elevator,

especially where an adjoining tooth has not yet erupted, great care must be exercised, or the unerupted tooth may be disinterred.

A deciduous first molar carious to the gum-level will sometimes simulate a premolar root, and the deception will be increased if the deciduous tooth be retained beyond its normal period. A careful examination of the root should clear up any doubt. Looseness, in the absence of inflammation, would strongly indicate a deciduous root. The resemblance may be sufficient to render desirable the exercise of great care in its removal. The blades of the forceps should be passed only sufficiently deeply to remove what is assumed to be a deciduous tooth until the sensation of resistance offered will determine its nature, and, thereby, the method of procedure.

Teeth are sometimes found united to each other at their roots (**gemination**). The resistance to removal that such will offer may be great. It is almost impossible to diagnose this condition, and, as it is not usually suspected, radiography is not brought into requisition.

Whilst exercising every care, it is at times impossible to avoid **removing with the tooth small portions of the alveolus**. Thus, especially with maxillary first molars, the outer alveolar wall is often thin and slight, and these thin portions yield more readily than does the periodontal membrane. That this accident may be unavoidable is evidenced by the difficulty in separating the broken alveolus from the extracted tooth.

This accident rarely occurs when the surrounding bone is thick, or the tooth necessitates rotatory movements for its detachment.

The removal of a small portion of alveolus, either with the tooth or directly following its removal, is not usually of any grave consequence unless it affects portions of

the adjoining sockets, causing looseness or necrosis of the tooth or teeth involved.

The alveolus may feel prominent after the extraction of several contiguous teeth, and give the patient the impression that some of the teeth have been broken. The treatment for this condition is oral cleanliness, and in a few days the sharp edges of bone will be rounded off and covered in with granulation tissue. It has been recommended to pare off the prominent portions with bone forceps, but this is rarely necessary, and may open up fresh bone to infection, especially as suppurative conditions of the gums are the chief factor in producing this bareness of the alveolus.

Should larger portions of the alveolus be fractured, their removal or retention will depend upon their size, position, and attachment to soft structures. If involving the stability of adjoining teeth, our efforts should be directed to their retention; or if forming part of the wall of one of the natural air cavities—*e.g.*, the antrum—their retention should be preserved, if possible, until such cavity is shut off from the mouth. Where, again, a large portion of the alveolus is fractured, but held in position by the surrounding soft structures, its retention should be preserved, provided it does not interfere seriously with mastication or with the patient's comfort.

Fracture of the mandible has occurred, the result of attempting to extract a tooth, and under the hands of those whose skilfulness as operators has never been questioned. It can be understood how this unfortunate complication might occur when only a moderate amount of force has been employed in cases where the jaw is the seat of some pathological condition—*e.g.*, atrophy or mollities ossium.

Fractures involving the alveolar plate of one or more teeth are of more frequent occurrence, and are recorded

from time to time. They occur generally in the maxilla, and the outer alveolar plate is the one usually involved.

Salter records a case where both the outer and inner plates of the alveolus were fractured during the removal of maxillary central incisors. The fracture passed through the entire thickness of the upper jaw, and was limited laterally by vertical fractures in the region of the canines, and above and below by horizontal fractures joining these at the level of the nose, and behind the incisor teeth, so that a portion of bone roughly corresponding to the two intermaxillæ was isolated, and held in position only by the soft tissues. Fortunately, this fracture united without any serious consequences.

Horizontal fractures of the outer, inner, or both alveolar plates of the mandible have at times occurred during the removal of a tooth, more especially a first permanent molar. The fracture is generally limited in its downward extent to the apices of the teeth, but may involve one or more alveoli.

Fracture of the maxillary tuberosity may occur during the removal of the maxillary third molar, and has sometimes followed that of the second molar. The fracture is generally limited to the tuberosity, but in some cases portions of the sphenoid and palate bones have been brought away. Such a case is recorded by Cattlin, and the ultimate result was deafness on the injured side. The hamular process and the tendon of the tensor palati muscle were involved, leading to collapse of the opening of the auditory tube, and permanent restriction of the movements of the jaw by the involvement of the pterygoid muscles and ligaments around the temporo-mandibular articulation.

The antrum is frequently laid open in these fractures, probably because the accident itself is largely determined by a weakened condition of the bone, due to an extensive

antral cavity. The opening, if small, will be temporarily closed by the elasticity of the tissues and blood-clot, and, provided the wound be left alone, no further trouble usually arises. If the opening into the antrum be extensive, a permanent communication with the mouth will result.

Dislocation of the Mandible.—This is almost invariably bilateral, and occurs most frequently during the extraction of a lower tooth while a patient is under anæsthesia. The relaxed condition of the muscles, the fulcrum formed by the mouth-prop or gag, and the depression of the condyle of the jaw in extracting a posterior molar, are probably the chief contributory causes to this accident.

A dislocation may not be apparent as long as the prop remains in the mouth, and frequently it is not until the patient returns to consciousness and the prop is removed that inability to close the mouth is noticed.

Apart from anæsthesia, dislocation may occur when a lower tooth—generally a posterior one—is being removed. It occasionally occurs under quite trivial circumstances—*e.g.*, on protruding the tongue, widely opening the mouth, or yawning; but under these conditions there is generally present some pathological condition of the temporo-mandibular joint—*e.g.*, laxity of the capsule (subluxation).

The condition is easily diagnosed. The mouth remains partly open, the lower jaw projects downwards and is fixed, and saliva is seen dribbling over the lower lip. The condyle can be detected in a false position, and a hollow can be seen and felt in its normal position in front of the tragus. The angle of the jaw passes backwards from the condyle, due to the obliquity of the ascending ramus. The coronoid process can be detected below the anterior part of the zygoma on bimanual examination.

As the capsule is not torn, the jaw is generally easily reduced by depressing the condyle below the level of the

eminentia articularis, the attachment of the temporal muscle to the coronoid process acting as a fulcrum, until the condyle is disengaged from the eminence, when the internal pterygoid, masseter, and posterior fibres of the temporal muscles will draw the jaw into its proper position.

The above is best carried out by standing in front of the patient, who should be seated. The thumbs are well wrapped round with thick napkins, or the corner of a towel, to a point beyond that enclosed by the lips, and pressure exerted with the thumbs in a downward and slightly backward direction in the molar region. The remaining fingers should be spread out under the chin, and exert pressure in an upward direction as soon as the condyle is felt to be disengaged.

In unilateral dislocation, the chin is directed towards the sound side, and there is a hollow present in front of the tragus on the injured side, which becomes noticeable on comparing the two sides. The jaw is not so widely opened, and allows of a little movement, by means of which the position of the dislocated condyle can be detected. Most of the other signs are present as before, their modification depending upon the unilateral condition present.

The reduction of a unilateral dislocation is carried out on precisely similar lines as when complete, except that the force exerted by the thumbs is applied to the injured side only.

A certain amount of **osteitis** follows the extraction of a tooth, but under favourable conditions this inflammation is temporary, lasting for two or three days, and only causing discomfort for a few hours. As teeth are generally removed for pathological conditions—either in themselves or of their surroundings—some degree of osteitis is frequently already present, and may have extended some distance from the primary focus. It is well to remember

this, as the removal of a tooth may not give immediate relief, and the condition may pass on to suppuration. If the patient is not informed of this beforehand, any subsequent pain or swelling may be put down to carelessness or neglect on the part of the operator.

Where an abscess is present, and the tooth is merely acting as a cork in preventing its escape, extraction will be followed by some immediate relief owing to the removal of tension.

Constitutional conditions—*e.g.*, debility, recovery from one of the exanthemata, etc.—may lead to infection of a wound which in a healthy person would heal quickly and soundly.

The causes of osteitis following upon extraction of teeth, apart from what must unavoidably occur through trauma, may be classified into *direct* and *indirect*, or immediate and remote. Of the former, trauma is the most important.

The amount of trauma inflicted in the removal of a tooth is least when the root is conical, and in these cases only a slight dilation of the socket around the neck of the tooth occurs. If the root be slightly tortuous or bent, the socket will be dilated or distorted over part of its extent.

In teeth with multiple or irregular roots, or where extensive lateral movements are necessary for loosening a tooth, a variable amount of distortion of the alveolus occurs, which, if carried beyond its limits of elasticity, will result in fracture.

The outer alveolus of an upper or lower canine is liable to be bent or displaced outwards during the extraction of these teeth, and similarly the outer alveolus of a first upper or lower molar, giving rise to discomfort and delay in the healing of the socket.

After the removal of a tooth, it is desirable to apply gentle but firm pressure on either side of the alveolus.

This will tend to reduce the alveolus to its natural form, and restore any distortion, should such have occurred.

A local osteitis, lasting a few days to a week or more, may follow injury to the alveolus in removing a portion of a tooth deeply embedded in the jaw, or after any difficult extraction, and is prolonged in the case of the mandible owing to the dense bone around and the less favourable conditions for drainage. Small portions of fractured alveolus may be exfoliated from the socket, or flakes of necrosed bone come away in the discharges. The soft tissues around the alveolus become inflamed and separated from the latter, exposing bare bone. The contour of the socket will be distorted or bulged in one or more places.

Pain is frequently intense for the first few days, but gradually diminishes if oral cleanliness is strictly carried out. Carbolic acid and potash* form a useful mouthwash for serving this purpose, the latter dissolving any adherent mucus, epithelium, or necrosed tissue, and allowing the former to pursue its antiseptic and anæsthetic properties.

Besides oral cleanliness, treatment will consist in removing loose fragments of bone, moulding the alveolus into its natural shape when recently injured, and swabbing out the socket with pure carbolic acid. This is best applied on a small piece of cotton-wool of a size that will readily pass down each separate root-socket, any excess being removed before its introduction.

A portion of bare alveolus will often closely resemble a fractured tooth, and the patient's symptoms will not aid

* ℞ Liquoris potassæ .. .. .. f ℥i.
Acidi carbolici liquefacti .. .. .. f ℥ss.
Tincturæ cocci .. .. q.s.
Aquam .. .. ad f ℥i.

Misce. Mitte ℥vi. Use one teaspoonful in half a tumbler of warm water.

in the diagnosis. The latter condition can be excluded if a probe passes freely down each socket, as well as by the other points mentioned.

The above method of treatment will be found useful in relieving pain, where portions of a live root have been left in the alveolus, if the action of the carbolic acid be restricted to the exposed portion of nerve. A superficial slough is formed, destroying the conduction of sensation, and the anæsthetic properties of carbolic acid may likewise assist towards the same end. A strong solution of silver nitrate may be used in a similar way. The action of the carbolic acid can be prolonged by combining it with glycerine. This makes a tenacious mixture, which is less easily washed away in the mouth.

Besides this local application, an anodyne mouthwash should be prescribed, and one of the most comforting is obtained by boiling 2 ounces of poppy-heads in 1 pint of water until reduced to ½ pint, and adding 10 grains of potassium chlorate to every ounce of poppy fomentation, or 10 minims of tincture of opium may be added to an ounce of a watery solution containing 10 grains of potassium chlorate.

This should be used as hot as can be comfortably borne in the mouth, and no doubt the warmth is as effective in relieving the pain as the contained drug.

The same may be used in these cases as a large fomentation applied externally, with but little danger of inducing the inflammation to spread from its local site.

The removal of a third mandibular molar is not infrequently followed by severe pain, lasting a few days to a week or more, even when the extraction has been a simple one. The proximity of the mandibular nerve probably accounts for the pain, and its continuance may be due to the irritation of the socket by the accumulation of food and débris. This supposition is favoured by the fact that pain-

ful sockets are usually those that are unprotected by nature's first dressing—the blood-clot.

The socket should be kept as clean as possible by careful syringing with an unirritating antiseptic, so as to promote healing by granulation tissue.

Laceration of the soft tissues may deprive the bone of its vascular supply to such an extent that necrosis results, or this sequela may arise from subsequent infection.

The terminations of the fifth nerve entering the apical foramina are necessarily torn during the removal of a tooth, and this separation is followed by a local neuritis, which may extend to the trunk of the nerve when in close proximity—*e.g.*, in the posterior lower molars—or affect the trunk subsequently if the wound becomes infected.

Fortunately, the fine nerve terminations generally rupture at their entrance to the apical foramina, and the neuritis is slight in amount and limited to this region.

Small portions of nerves will sometimes remain attached to the roots of the teeth. This occurs more especially with maxillary molars and canines that are free from extensive caries. The condition is frequently associated with maxillary canine teeth erupting outside the dental arch. The attached portion of nerve is rarely more than $\frac{1}{8}$ inch in length, and is frequently found on each root of the molar tooth.

No subsequent trouble appears to follow this condition.

Why in some cases small portions of nerves remain attached to the ends of the roots while in other teeth the nerve breaks at the apical foramen is difficult to explain, and certainly does not depend upon any constriction at this point, or else we should expect to find portions of nerves attached to teeth which have large apical foramina, whereas in connection with these teeth the condition is excessively rare.

The reason may be that the maxillary molar and canine teeth are supplied by short branches, given off at right angles from the convexity of the arch formed by the inosculation of the anterior and posterior dental nerves, and so are more readily broken off at this point.

The mandibular third molar may have a very direct relation to the trunk of the inferior alveolar nerve, and grooves may be detected near the termination of its roots, along which the nerve lay. Sewill records a case where one root was perforated and the other grooved by the inferior alveolar nerve, the extraction of the tooth being followed by temporary loss of sensation over the region supplied.

The sensory area supplied by the inferior alveolar nerve corresponds roughly to the chin, both surfaces of the lower lip from the middle line to the first premolar, and the gums around the lower teeth.

Loss of sensation (epicritic and protopathic sensibility of Head and Sherren) incurred from injury of the inferior alveolar nerve is generally temporary, and this area is somewhat diminished by the overlapping of the sensory fibres in the fifth and seventh nerves, more especially the lingual, long buccal, and supramandibular nerves. Deep sensibility is unaffected.

The **lingual nerve** is liable to injury, during the extraction of a mandibular third molar, as it passes from under cover of the internal pterygoid muscle to the side of the tongue. In this position the nerve lies about $\frac{3}{4}$ inch behind and below the last molar tooth, and is only covered by mucous membrane.

Injury to the lingual nerve will result in a loss of sensation over the anterior two-thirds of the tongue, adjacent portion of the floor of the mouth, and inner side of the jaw. There is also paralysis of the submaxillary and sublingual salivary glands, with diminished secretion and

loss or impairment of taste over a corresponding portion of the tongue.

The remote causes of periostitis and osteitis resulting from the removal of a tooth are chiefly referable to **sepsis.**

Pyogenic organisms may be introduced during extraction by unclean instruments or hands, or subsequently through lack in maintaining oral cleanliness, the former being the fault of the operator, unless the mouth at the time of the operation was in an unhealthy condition.

The inflammation following will be severe, according to the condition of the mouth, the variety of organism introduced, the position of the wound, and the precautions taken in treating the patient.

After the removal of a tooth, besides prescribing a mouth-wash, the patient should be limited to a soft, or, better, a fluid diet for a day or two.

If the teeth, gums, and cheeks be in an unhealthy condition—*e.g.*, ulcerative stomatitis in children—it is often desirable to delay extraction until the mouth is brought into a more healthy condition, as any wound in the mouth is liable to become infected from its surroundings.

No doubt the removal of " septic " teeth is desirable in getting the mouth into a more healthy condition. Still, there are cases where the infliction of a wound under such conditions is most undesirable, and the author has seen on more than one occasion a **localized gangrenous stomatitis** commence from such a wound, involve the sockets of some of the adjacent teeth, and lead to necrosis and gangrene of the soft parts.

Severe cases of ulcerative stomatitis are frequently seen in young children improperly clothed and fed, and living in poor, crowded, and unhygienic surroundings.

Ulcerative stomatitis in its severer forms may closely

resemble cancrum oris, and the two conditions may be different degrees of the same disease; whether the gangrene remains localized or spreads, as in cancrum oris, depending upon the virulence of the infection and the debility of the patient.

When the condition is less serious, the child's mouth may be brought into a more healthy condition by cleansing the teeth and gums with absorbent cotton-wool soaked in a solution of potassium chlorate (20 grains to 1 ounce), or in older children a more diluted solution of this may be used as a mouthwash. Potassium chlorate can in addition be administered internally up to 12 grains in the twenty-four hours.

A soft brush may be substituted for the wool when the gums and mucous membranes become less tender. The bowels in this illness are almost invariably confined, and castor oil forms a useful purgative, and may be advantageously combined with a little brandy.

The mouth may be brought into a much cleaner condition after a few days of treatment, and any tooth causing pain, swelling, or aggravating the stomatitis, can be removed; but as a rule this condition, when extensive, does not primarily depend upon a local cause, and any swelling around a tooth must be regarded as of secondary importance, the constitutional condition of the patient being a far more important factor.

Frequently the teeth are found, after removal of the débris in which they were embedded, to be free from caries and healthy, although well-marked ulceration of the gums and cheek may be present in their neighbourhood.

Treatment after extraction will consist in oral cleanliness, syringing the sockets with some warm non-irritating antiseptic—*e.g.*, boracic lotion—especially after meals, and removing any loose or necrosed fragments of bone. A

saline purgative* should be prescribed, and, if necessary, a tonic.† For these purposes the undermentioned are useful formulæ.

When suppuration from a tooth-socket has continued for some months, small portions of the jaw may undergo **necrosis** and exfoliate.

Some years ago the author removed a loose piece of necrosed bone extending from the left third molar to the right incisor tooth. The sequestrum involved the sockets of the molar teeth, the inner alveolus of the remaining teeth, and portions of the body of the mandible. There was no history of syphilis. The patient dated his trouble from the removal of a mandibular left molar two years previously. In this connection it may be remarked that a history of two years' duration is not unusual in necrosis of the mandible, where sequestration of bone is very slow.

Suppuration from a mandibular tooth, generally a molar, will sometimes track some distance beneath the deep cervical fascia (Ludwig's angina), even as far as the clavicle, and in a few recorded cases into the mediastina, and may terminate fatally.

These cases sometimes require, besides removal of the tooth, a counter-opening in the neck at the most dependent part of the swelling. These are serious cases requiring immediate attention, and must be referred to a surgeon.

* ℞ Magnesii sulphatis .. .. .. ℥i.
Acidi sulphurici dil. .. .. .. ♏x.
Syrupi papaveris rubri .. .. .. ℥ss.
Aquam menthæ piperitæ .. .. .. ad f ℥i.
Misce.

† ℞ Liquoris strychninæ hydrochloridi .. .. ♏iii.
Acidi phosphorici dil. .. .. .. ♏xv.
Spiriti chloroformi .. .. .. ♏xv.
Infusi quassiæ .. .. ad f ℥i.
Misce.

The two operations may be done at the same time, while the patient is an inmate of a hospital, nursing home, or at his own home.

Laceration of the gum has been mentioned previously. In most cases, when separated from the alveolus, the gum will regain its attachment if the mouth be kept clean.

Any pendulous portions may be snipped off, and the remainder, if necessary, stitched with one or more silk sutures to the opposite lip of the socket, but as a rule the gum tends to lie in this position without further aid.

In the removal of a mandibular third molar, and less frequently with other teeth, the gum will occasionally

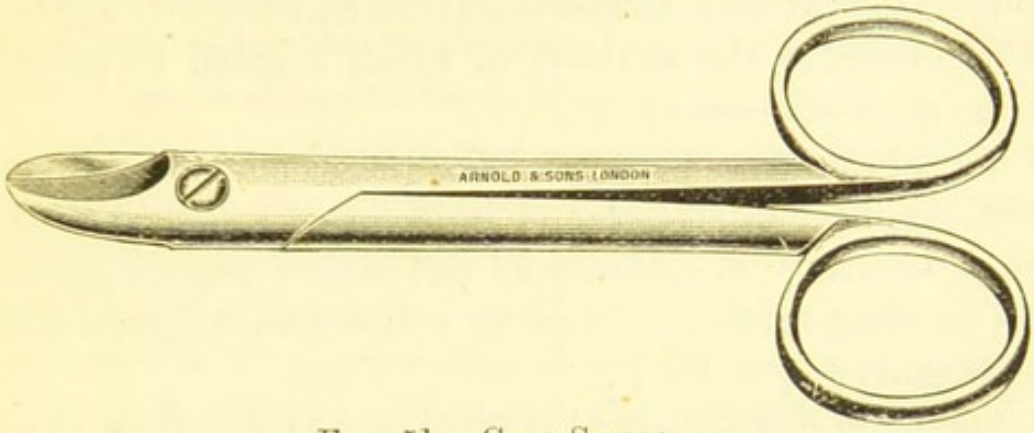

FIG. 51.—GUM SCISSORS.

remain adherent after the tooth is loosened or actually lying in the mouth.

If the gum only remains slightly adherent, the tooth can easily be separated by a slight twist, if at the same time the attached soft tissues are held down with the finger. If more firmly adherent, the tooth may be left until its attachment can be divided with curved scissors (Fig. 51) or lancet.

The gum is more liable to remain adherent to teeth that are removed with an elevator, because the tooth travels upwards and backwards, and lifts the gum from the bone instead of being itself drawn away from the gum.

The isolation of the mandibular third molar posteriorly and the loose attachment of the soft tissues in this region are factors that contribute to this accident.

Hæmorrhage from laceration of the gum is rarely serious, although it may be profuse for a short time, and is generally soon controlled by the use of cold, either in the form of a mouthwash, or as an ice-pack made by filling small calico bags with pieces of broken-up ice. The bag is laid across the alveolus, and held there with a finger by the patient or operator, replacing the bag with fresh ones if necessary. If a mouthwash can be used with comfort sufficiently hot to arrest the hæmorrhage, this is a pleasanter method to employ. Heat as a hæmostatic is most efficiently applied in the form of the cautery, of which a small Paquelin's is the most convenient.

If cold applications fail to stop the hæmorrhage, tannic acid dissolved in glycerine (1 in 5) may be applied to the gums, or soaked in cotton-wool and packed directly against the bleeding surface, or used as a mouthwash (glycerinum acidi tannici, 1 in 8).

Adrenalin (0·1 per cent.) is likewise useful in these cases, combined with plugging.

If these means fail, stitching up a socket will often arrest hæmorrhage almost immediately, and at the same time cover any bare alveolus.

Injury to the floor of the mouth may occur in removing a lower back tooth if the inner blade be too widely opened, or where a tooth inclines inwards towards the floor of the mouth. The mucous membrane in this region is loose and in folds, and during anæsthesia becomes swollen and turgid, filling up the space between the tongue and teeth, and often pushed over towards the latter by the swollen tongue.

Wounds of the tongue are usually due to carelessness. The slipping of an elevator or forceps would account for

such an accident. Hæmorrhage may be at first profuse, but will as rapidly diminish unless a large branch of the lingual artery be involved.

As the wound is generally a small puncture, a single suture will bring the edges firmly together, should such be necessary.

If blood spurts freely from the puncture, indicating that an artery of some size is involved, the finger should be passed well to the back of the mouth, and the base of the tongue hooked forward against the hyoid bone. This compresses the lingual artery against the hyoid bone, and an attempt should then be made to seize the vessel with pressure forceps, temporarily relaxing the compression to see from where the hæmorrhage is arising. Failing this, means must be obtained for ligature of the artery.

In addition to wounds of the tongue and floor of the mouth through the slipping of an instrument, **the lips may be injured** in a similar way, or actually perforated, as has occurred during the extraction of a maxillary incisor tooth. The blades of the forceps slipped and perforated the upper lip, which, however, in a few days was soundly healed.

In this position hæmorrhage can be easily controlled by compressing the lip between the fingers, or by pressure over the maxilla, when the bleeding-point is above the lip sulcus. The hæmorrhage will usually cease spontaneously, and will rarely require the ligature of any vessel.

The lower lip is liable to be bruised against the lower teeth during the extraction of the maxillary teeth. This should be avoided by using forceps with handles at such an angle to the blades as to be clear of the lower lip during the extractive movements. This accident occurs more often during anæsthesia, and while the inward movements are being conveyed to an upper molar, especially when the mouth is insufficiently opened by a prop or gag.

The operator may be unaware of any untoward result until the lip begins to swell on the following day, or earlier. The application of a simple ointment containing oxide of zinc, or boric acid, is all that is generally required. The skin is not as a rule broken, and in a day or two the swelling subsides. The swelling from such a bruise will sometimes rapidly appear, and in less than an hour the whole lip may be involved in a bluish, tense swelling consisting chiefly of extravasated blood.

A root may be forced into the antrum, especially that of a maxillary premolar or molar, during attempts at its removal, and from the anatomy of this part (Fig. 52), and its condition when inflamed, such an accident would be expected to occur more frequently than it apparently does.

FIG. 52.—SHOWING THE RELATION OF A MOLAR TOOTH TO THE MAXILLARY ANTRUM. (Royal Dental Hospital Museum.)

The conditions which might induce such an accident would be attempts at removing a premolar root or the buccal roots of a first or second molar, especially if ill-defined, during which one or both blades of the instrument may be directly pressing on to the surface of the root, and so dislodge it partly or entirely into the antrum. Again, the root may be only just within the grasp of the blades, and in closing the latter the root is shot out of their grasp deeper into the tissues, or even into the antrum.

When a tooth or root has been forced into the antrum, the treatment to pursue will depend upon whether the tooth or root was previously healthy and the condition of the antrum.

Treatment on expectant lines is indicated, unless the

antral cavity becomes infected, in which case the foreign body must be removed. If the root is only partially projecting into the antrum, fine forceps are chosen, and their blades kept apart until well down on the root, when they should be gently but firmly closed, and if a fair grasp of the tooth is obtained, it will probably be easily removed.

The subsequent inflammation may have loosened and extruded the root, so that a grasp is easier to obtain, but very little force in the opposite direction will be sufficient to dislodge the root completely into the antrum.

There are no pathogenic signs of partial dislodgment of a root into the antrum, and the condition can only be surmised when a maxillary premolar or molar root appears to sink deeper into the jaw on attempts at extraction. Subsequent signs of infection of the antrum would make it appear probable that such an accident had occurred. Whether partial or complete dislodgment of a root into the antrum is suspected, a radiograph should be obtained. A healthy tooth or root in the antrum will become encysted, and probably never give rise to trouble, and treatment will consist in keeping the socket clean. The perforation will be almost immediately closed by blood-clot, and in a few weeks permanently shut off by the deposit of fibrous tissue or bone.

If the antrum has previously been diseased, or the contained tooth or root subsequently causes inflammation or suppuration of its cavity, it is desirable to get rid of the foreign body, and the method to employ will depend upon its localization by radiography.

If the foreign body lies at the orifice of the perforation into the antrum, it may be possible to remove it by means of a small spoon-shaped excavator or bent wire; but, failing these means, the perforation must be enlarged sufficiently to admit the finger, and the removal effected. The antrum should be treated according to its pathological condition.

In a similar way **a root may be forced into an abscess cavity or cyst,** but a more common accident is for a root to become dislodged and forced into a space caused by the separation of the muco-periosteum from the jaw, especially where the mucous membrane is but loosely attached, as on the inner side of a mandibular third molar.

This accident is liable to occur in elevating a mandibular third molar from its socket. The tooth travels upwards and backwards, stripping the loose muco-periosteum from off the jaw in the region of the internal pterygoid muscle, and giving the impression that the tooth has left its socket and fallen into the mouth. Again, in removing the second root of a mandibular molar with a curved elevator, if the socket has been previously damaged, the root may be forced between the gum and the alveolus.

Where there is much oozing of blood and the tissues have been previously damaged, it may be very difficult to localize the missing root, and it may be advisable to wait until bleeding has ceased and inflammation partly subsided, when the root may be clearly seen between the gum and alveolus, or in some other unnatural position, and easily removed.

The treatment of an abscess or cyst necessitates a free opening, and through this the foreign body can be easily removed.

Most of the above conditions are more liable to occur when removing teeth under anæsthesia, while, in addition, there are certain accidents which occur almost solely under anæsthetics. These will be mentioned in connection with that chapter.

Hæmorrhage following Tooth Extraction.

The arterial supply of the maxilla and mandible and their surrounding parts is derived from the external carotid

artery. The maxillary teeth are supplied by the anterior and posterior dental arteries, while those of the mandible receive their arterial supply from the inferior dental artery —branches of the internal maxillary.

The surrounding soft tissues on the outer side of the jaws are supplied chiefly by the facial artery, and on the inner side by the internal maxillary (deep facial) and lingual arteries.

Hæmorrhage following tooth extraction is derived from two sources: the alveolus, or bone surrounding the teeth, and the mucous membrane covering the jaws, the larger quantity being derived from the former source.

Normally, such hæmorrhage ceases within half an hour, and in less than five minutes after the extraction of a tooth there is nothing more than a slight oozing of blood from the wound.

About half an ounce may be regarded as an average amount of blood lost after the extraction of a tooth, but this may vary up to two or three ounces or more without being excessive, and will be several times this amount before giving rise to any unpleasant symptoms.

Hæmorrhage is generally more profuse if inflammatory conditions of the mucous membrane and their surrounding parts be present—*e.g.*, *periostitis* and *osteitis*. Pathological conditions causing engorgement of the neighbouring vessels will also increase the hæmorrhage—*e.g.*, *polypi, granulomata, ulcers, new growths, and nævi.*

Excessive bleeding will sometimes follow the removal of teeth affected with pyorrhœa alveolaris, and in elderly people suffering from this disease it may be advisable to limit the extraction to a few teeth at a time.

Hæmorrhage after tooth extraction may be excessive, or even fatal, when certain constitutional conditions are present, and some of these are included under the term of

"blood diseases," comprising *scurvy, purpura, leukæmia, and hæmophilia.*

Hæmorrhage may be profuse if tooth extraction be undertaken during a *menstrual period*, and such hæmorrhage may partially or entirely replace a normal menstruation, in the same way as epistaxis will replace menstrual bleeding when occurring at this period.

Free hæmorrhage is liable to attend operations upon patients suffering from *jaundice*, but whether tooth extraction is affected unfavourably in this way seems doubtful.

Hæmophilia is by far the most important of the constitutional conditions that may be present at the time of the extraction of a tooth, or during any operation involving the cutting or tearing of bloodvessels. For an account of this disease the reader is referred to the author's paper entitled "Hæmophilia from a Dental Aspect."*

The rule that the **extraction of teeth must never be undertaken in hæmophilic patients** can have no exception even for its proof.

No operation involving the discontinuity of bloodvessels must be undertaken, unless the patient's life be in danger through want of that particular operation, and for which no other method of treatment can be substituted.

If the removal of a tooth be undertaken, unaware that the patient is the subject of hæmophilia, and profuse and continued bleeding follows, the wound must be cleansed, and treatment directed to bringing about a rapid coagulation of blood and a firm clot. The socket of a tooth, from a mechanical point of view, is favourable for plugging, but the latter is only of use in aiding coagulation of blood by causing stagnation, and where the power of coagulation is diminished, or almost absent, bleeding will continue whether a socket be plugged or not. It is usually not

* Royal Dental Hospital Reports, 1910.

until well-tried plugging has failed that the case assumes a grave aspect.

Calcium salts have approved themselves to be a mainstay in many cases of hæmophilia, and where they have not been absorbed, those of magnesium (carbonate and lactate) have given good results. Wright recommends in active hæmorrhage 1 gramme, or less, of calcium chloride or lactate for young children, and 4 grammes for an adult, or a mixture of magnesium carbonate or lactate with calcium chloride or lactate. On repeating the dosage, one-half of these quantities of calcium salts may be given. Calcium salts are said to retard coagulation if a certain percentage is exceeded, and from this it is obvious that no absolute rule can be laid down as to dosage, as it is impossible to tell, apart from experiment, whether the drug or drugs will be absorbed, or whether the patient's blood may not already contain the optimum of calcium and magnesium. The disagreeable, bitter taste of calcium can be mitigated by cinnamon or peppermint. Useful formulæ for administering calcium chloride are the following:

℞ Calcii chloridi .. .. grs. 100
Mucilaginis acaciæ .. .. .. ℥xii.
Tincturæ cinnamomi .. .. .. ℥ii.ss.
Aquæ .. .. ℥ii.ss.
Lactem ad .. .. ℥vi.

Two tablespoonfuls of the mixture for a dose.

℞ Calcii chloridi .. .. grs. 75
Syrupi aurantii .. .. ℥x.
Spiritus vini Gallici .. .. .. ℥i.
Tincturæ cinnamomi .. .. .. ℥i.
Aquæ .. .. ℥ii.

One tablespoonful of the mixture for a dose.

Calcium lactate has a less objectionable taste than the chloride, and may be given in 10- to 15-grain doses in

chloroform water. The administration of calcium should be gradually reduced after bleeding has ceased.

Styptics may be divided into escharotic and physiological, but only the latter class are permissible in hæmophilia, as the former, producing their effect by forming a plug out of the destroyed tissue, are apt to be followed by a renewal of bleeding on the separation of the eschar. Wright recommends an extract of thymus gland, reinforced by 1 per cent. of calcium chloride, and mentions good results from its use. He regards it as the most potent physiological styptic available. The wound should be plugged with wool or lint soaked in the styptic.

"Tabloids" of thymus gland (B. W. and Co., 5 grains each), administered up to twenty a day, will supply the blood with the nucleo-albuminous element, which it probably needs. With the same idea of supplying the fibrinoplastic element to the blood, it has been suggested that human blood should be applied to the wound in hæmophilic hæmorrhage, and allowed to clot there. Serum has been suggested for a similar purpose, used locally, or as an injection (Broca). The control of hæmorrhage by this means is only temporary unless clotting takes place in the lumina of the open vessels, as well as in their immediate surroundings. Ergot may be of some use in contracting the arterioles, but unless an internal clot is also formed, this will have but little effect on the capillaries, and the same may be said of adrenalin chloride. Gelatin has been employed locally, and as an injection, it is said to be of some value when used by the latter method if unsterilized; but this introduces a risk of the supervention of tetanus.

The inhalation of carbon dioxide as a means of treatment is based on the fact that the amount of intravascular clotting produced by the injection of a solution of nucleo-albumin (Wooldridge's tissue fibrinogen) can be increased

or diminished by correspondingly varying the venosity of the blood. The carbon dioxide is evolved by the action of an acid on chalk, the gas is led off to the patient by means of a rubber delivery tube; a washbottle being interposed between the latter and the gasogene. In administering the gas care must be taken to deliver it only in a small stream, so as to avoid the acceleration and deepening of the respiratory movements which are produced by means of carbon dioxide.

All active surgical means for the arrest of hæmorrhage, such as compression and ligature of arteries, are inadmissible in hæmophilia.

As a means of amending the congenital defect, the administration of ovarian extract to male bleeders has been suggested.

One of the first of local remedies to apply should be a graduated *compress* used dry or soaked in a watery extract of thymus gland and calcium chloride (1 per cent.), and firmly kept in position without, if possible, *fixing the jaws*. The compress should be allowed to work out by itself, the mouth in the meantime being kept as clean as circumstances permit, or else the plugging will become very foul and predispose to secondary hæmorrhage.

The objection to fixing the jaws, besides rendering cleanliness of the mouth difficult to obtain, is that bleeding may continue after plugging without any external indications.

Suturing the lips of a socket is not likely to be so effective here, as in dealing with excessive hæmorrhage dependent upon a local cause; if employed, the sutures should be passed deeply across the socket, and the surface of the wound afterwards compressed by folds of lint or gauze, kept in position by a wedge of wood or other material, between the adjacent teeth.

As a last resource the *cautery* may be applied; but all

active local treatment is better avoided, as, even if effective, bleeding is liable to result after the separation of the sloughs.

Pressure on a main artery supplying the part is inadmissible, the necessary bruising being followed by ecchymosis, and its effects only lasting as long as the pressure is maintained.

Rectal infusion of warm saline solution or other bland fluid is of use in temporarily replacing the blood lost, but will require repeating if bleeding continues. A drachm of calcium chloride may be added to each pint of fluid used.

In addition to the above, *the patient must be kept quiet, his head raised, and body well wrapped up in blankets.* He should only be given a *slop diet* for several days, although this must be nourishing and in sufficient quantity to keep up his strength. All liquids must be given cold as long as bleeding continues, and only gradually warmed after bleeding has ceased.

Alcohol should generally be withheld while bleeding continues, and afterwards regulated by the pulse.

Between attacks cod-liver oil is useful for children. Warm clothing, cold bathing, and a dry and bracing climate are recommended, while all games, except the very quietest, should be *absolutely forbidden.*

The treatment of *excessive bleeding* following tooth extraction in the absence of the above conditions is much more satisfactory, and local measures are generally effective in controlling the hæmorrhage.

Blood in a healthy person tends to coagulate within five minutes of leaving the vessel wall. The latter is innervated from the vasomotor centre in the medulla, and maintained in a constant state of tension or contraction, commonly known as tone, through its muscular coat. When an

artery is divided, the longitudinal tension being removed, the muscular coat contracts and curls up, carrying with it the internal coat into the lumen of the vessel; the external coat contracts independently within the vessel sheath, owing to its contained elastic fibres. The walls of capillaries and veins tend to collapse as soon as the blood ceases to circulate in them.

When from some cause or other the above changes do not readily take place, and bleeding continues, treatment directed towards the arrest of this bleeding becomes necessary.

Ordinary, or what may be termed normal, hæmorrhage following tooth extraction requires no further treatment beyond allowing the patient to emit the blood from his mouth and keeping the latter clean.

Before considering the treatment of excessive hæmorrhage following tooth extraction, it will be necessary to mention briefly Nature's means of arresting hæmorrhage, as by a knowledge of this both the cause of the bleeding and its treatment may become apparent.

The **natural arrest of hæmorrhage** is brought about by processes which for convenience are divided into *temporary* and *permanent*, or early and late. All artificial means should be directed towards aiding the former, as the permanent arrest of hæmorrhage consists in changes compatible with those of repair of tissue, over which we have but little control, except by the avoidance of sepsis.

The temporary arrest of hæmorrhage is brought about by certain conditions, which may be classified into general and local. In the slighter cases the latter are probably the more important, the former only participating to any extent in the severer forms of hæmorrhage.

Local Conditions which aid in the Arrest of Hæmorrhage.

1. *Retraction and contraction of the artery* within its sheath.

2. The formation of the *external clot* within the sheath of the vessel and around its lumen, acting as a buffer at its open end.

3. The formation of the *internal clot* within the lumen of the vessel, extending from the external clot to the last patent branch, and depending upon the efficiency of the external clot for its formation.

General Conditions which aid in the Arrest of Hæmorrhage.

1. Diminution in the *force* of the heart's action, owing to its containing less blood to contract upon.

2. Increased *coagulability* of the blood after severe hæmorrhage.

3. Rest consequent on the *syncope* arising from the loss of blood.

Hæmorrhage (Arterial) is divided into—

1. *Primary.*
2. *Recurrent, reactionary, or intermediate.*
3. *Secondary.*

1. *Primary hæmorrhage* is that hæmorrhage which results immediately from a lesion of a bloodvessel, interrupting its continuity, and may arise from a direct or subcutaneous injury.

2. *Recurrent hæmorrhage* arises from the failure of Nature's or the surgeon's methods of temporary arrest of hæmorrhage—*e.g.*, the displacement of a blood-clot, the

slipping of a ligature, the loosening of a plug in a tooth-socket.

3. *Secondary hæmorrhage* results from the failure of Nature's method of permanent arrest of hæmorrhage.

Hæmorrhage following tooth extraction may come under any of the above headings. The condition necessary for *recurrent hæmorrhage* is the increased action of the heart following upon its temporary depression from loss of blood or syncope, which dislodges the blood-clot occluding the lumen of the vessel or the surgeon's ligature or plug.

Secondary hæmorrhage is now less frequently seen, since the establishment of aseptic surgery. The mouth is probably the commonest position for this type of hæmorrhage, owing to the great difficulties of obtaining *asepsis*.

Treatment of Excessive Hæmorrhage following upon Tooth Extraction.

A *clear view* of the bleeding spot must be obtained. Loose blood-clots must, if necessary, be washed away with a stream of cold water, or, if adherent, gently wiped away with a swab.

When the source of hæmorrhage is detected, the wound should be allowed to become freely *exposed to the air*. This exposure is an excellent hæmostatic, and alone is often sufficient to stop slight bleeding.

The *character* of the bleeding must be observed, as both its site and character will help in determining the subsequent treatment to pursue.

On no account should a socket be plugged before observing the site and character of the bleeding, or rational means cannot be directed towards its arrest.

The author has frequently seen bleeding continue solely through meddlesome treatment, plugging, styptics, hot and

cold water being used alternately or together, regardless as to why the bleeding continued, and aimless in its method of prevention: on removing the plugging material, and allowing the wound to become exposed to the air, bleeding ceased within a few minutes.

Plugging should not be hastily resorted to, although it may be the saving of a small quantity of blood, for we must realize that it has compensatory disadvantages in preventing primary union of the wound, and rendering it open to infection. The blood-clot filling the wound forms the best plug, besides acting as scaffolding for the permanent reparative tissue.

Slight hæmorrhage will usually cease spontaneously if the wound be exposed to the air and the patient assume the *semi-recumbent position*, remain quiet, and refrain from constantly spitting.

The blood should be allowed to collect and trickle out of the mouth into some vessel held close under the chin, or be occasionally washed away with a little cold water, so as to *avoid the suction action* that is produced by spitting.

During this time the amount of hæmorrhage can be roughly gauged, and it must be remembered that the amount of blood lost is always more apparent than real. A few drops of pure blood will colour an ounce or more of saliva, so that it will appear almost like pure blood, while the presence of blood in the mouth promotes salivation.

After about half an hour, if blood is still oozing from the socket, more active measures may be necessary; in most cases the hæmorrhage would cease of its own account before many ounces of blood were lost, but it is not safe to adopt this expectant treatment unless the patient can be watched.

The wound should be once more carefully examined, noticing whether the hæmorrhage is as copious as pre-

viously, the presence of fresh clots, and from other conditions forming an idea as to the best treatment to pursue.

As hæmorrhage is more liable to follow from a damaged socket, the latter should be carefully examined for loose portions of tooth or alveolus, which should be *removed*, as well as pendulous portions of gum, if obscuring the view, or in other ways hindering treatment.

If *syringing a socket with cold water* fails to arrest the hæmorrhage, the application of ice, either loose or in the form of an ice-bag, would probably likewise be inadequate, even if immediately obtainable.

Hæmorrhage still continuing, pressure in some form or other over the bleeding area becomes necessary, and one of the best ways of carrying this out is by *plugging the socket.*

For this purpose narrow strips of ribbon gauze, of about $\frac{1}{4}$ inch in width, but varying with the size of the socket, are the most convenient. These strips may be advantageously soaked in a solution of adrenalin (0·1 per cent.).

The gauze must be packed firmly into the socket to the level of the gum, using one strip when possible, as a tighter plug can in this way be obtained, and its removal effected more easily and with less liability of disturbing any clot after bleeding has once ceased.

Gauze saturated with blood closely resembles blood-clot, and if in mistake the latter be disturbed, fresh hæmorrhage may result; whereas when a single piece of gauze is used, and the end left projecting from the wound, this mistake will not occur.

It is most important that the deeper portion of the socket be very firmly plugged, the integrity, and so the success, of the plug depending on this portion.

After plugging the socket, the mouth must be examined to see that bleeding has ceased, or is likely to cease with

the additional pressure gained by *fixing the jaws*. To fix the jaws by bandaging directly after plugging the socket, without ascertaining how far the plugging has been successful in controlling the hæmorrhage, may court disaster by obscuring from view any subsequent bleeding.

If the plugging has only partially arrested the hæmorrhage, a firm pad of gauze is laid across the wound to the level of or above the adjacent teeth, according to the bite, or in edentulous cases so that the opposing gum is driven well into the gauze. The jaws are then firmly closed and bandaged.

It is better, when possible, to avoid fixing the jaws, owing to the discomfort it entails, and the possibility of a recurrence of hæmorrhage, which cannot be detected. If there be doubt as to the efficiency of the plug in the socket, this should be reapplied with firmer pressure rather than trusting to the increased pressure gained on fixing the jaws.

The patient must be watched for at least an hour after the bleeding has ceased, and must be informed as to *diet* and *sleep*.

He should know the precautions to observe to prevent further bleeding, and those to take in the event of its occurrence.

A cold liquid diet is alone permissible while bleeding continues, and this is best taken in the form of milk, beef-tea, or one of the essences of meat containing the extractives. Stimulants and hot drinks are to be avoided, as by causing a dilatation of the peripheral vessels they may dislodge some blood-clot and encourage fresh bleeding.

It is better for the patient to refrain from all liquid food for some hours, especially where the teeth must be slightly separated for feeding purposes.

He must lie quiet, in a semi-recumbent position, and

during the night his *head and shoulders should be kept slightly raised* by a firm cushion placed beneath the pillow. His body must be kept warm.

The patient should be again seen within twenty-four hours, the bandages removed, and the mouth gently opened.

After carefully removing the superficial pad of gauze, the plugged socket should be inspected, and the plugging allowed to remain, if removal would be likely to cause renewed bleeding. The plugging has been protected by the overlying pad of gauze from the saliva and fluids of the mouth, so that it can usually be retained, without harmful effects, for a little longer period.

The mouth should be occasionally washed out with some weak antiseptic, and the plugging kept as clean as circumstances permit.

On the second day the plugging will usually be loosened, and can be carefully withdrawn without much fear of restarting the hæmorrhage.

Styptics are rarely successful in arresting hæmorrhage, except in slight cases, but may be usefully combined with plugging.

Using the extracted tooth as a plug has been suggested, and found useful in troublesome hæmorrhage. Its adaptation for this purpose should be ideal where the socket is uninjured, and if the tooth be healthy and uncontaminated, there can be no objection to its use. The jaws will usually require to be fixed, after interposing a pad of gauze between the opposing teeth; or the tooth covered over with the gauze may be introduced into the socket in a similar way to a petticoated tampon, the free ends of the gauze being rolled up so as to form a pad over the crown, into which the opposing teeth are driven when the jaws are fixed.

Suture is a method not much used for controlling hæmor-

rhage from a tooth socket, but may be usefully employed when the mucous membrane is sufficiently free to be brought firmly together over the wound.

A small curved Hagedorn needle, threaded on stout silk, is best adapted for this purpose. As much of the free mucous membrane as possible must be taken up in the suture on either side. Two or three sutures are generally sufficient to firmly approximate the lips of the socket.

A method which the author has found useful is to bring the lips of the socket together with two or more silk sutures, the tied ends of which are left long so as to be brought round and secured over a pad of gauze placed across the socket. The patient is then directed to bite into the pad, and the chin is bandaged to the head.

This method has the advantage that when hæmorrhage has apparently ceased, the pressure can be removed gradually, and so with less risk of inducing fresh bleeding. The jaws may first be released and the mouth inspected, and if bleeding has ceased, the pad may next be removed by snipping through the silk loops, the wound being still closed by the tied silk sutures. These may be left for two or three days longer, or allowed to work out by themselves. As there is no plugging in the socket, when the silk sutures come away, the wound will be found almost healed.

Gauze should seldom be left in the mouth for more than twenty-four hours, and this should be the extreme limit where the jaws are fixed and oral cleanliness prevented.*

The value of the treatment of hæmorrhage by drugs is difficult to gauge, as the tendency for hæmorrhage to cease spontaneously is so great, besides which their application

* "The Use and Abuse of Dressings in the Treatment of Wounds of the Mouth," by F. Coleman (Royal Dental Hospital Reports, 1912).

is generally combined with pressure, itself an important factor in the arrest of hæmorrhage.

The drugs used for the treatment of hæmorrhage are chiefly the organic and metallic styptics, such as salts of lead, copper, silver, zinc, iron, bismuth, hamamelis, ergot, tannic acid, alum, dilute sulphuric acid, and adrenalin.

Some styptics arrest hæmorrhage by causing a *contraction of the muscular coats* of a vessel—*e.g.*, cold, salts of lead and silver, alum, and hamamelis; others by *coagulating the albumin* in and around the vessel walls—*e.g.*, the tannic acid group, salts of lead, silver, zinc, copper, iron, bismuth, and alum. Some drugs act on the muscular coat of the vessel, as well as coagulating its contained albuminous fluids—*e.g.*, the salts of lead and silver.

The proteid-tannate which is precipitated by tannic acid is soluble in excess of albumin, so that before applying tannic acid for arresting hæmorrhage, it is necessary to remove blood-clots, and allow the drug to come into direct contact with the bleeding spot. Proteid-tannate is also soluble in excess of acids or alkalies, so that tannic acid is inadmissible after the use of most other drugs.

Pure or strong solutions of tannic acid cause a superficial precipitate, which prevents its penetration to the lumina of the vessels if there be much exudation or blood.

Both tannic acid and lead are conveniently combined with glycerine, the lead in the form of the sub-acetate. The glycerine allows these drugs to come into more intimate contact with the bleeding surface, and prevents their being washed away so easily in the mouth; or they may be applied on the gauze used for plugging the wound.

Tannic acid is also usefully applied, combined with collodion, in the form of styptic colloid (tannic acid, 20 per cent.), the evaporation of the solvent leaving the wound

covered with a thin layer of collodion impregnated with tannic acid.

Tannic acid, when applied directly to the bleeding spot, is best used in the form of the pure acid.

Hamamelis is an astringent, and hæmostatic on account of its contained tannin (8 per cent.).

Adrenalin should be used in 0·1 per cent. watery or saline solution, and may be combined with carbolic acid, tannin, or other drugs, and applied on sterile gauze, wool, or whatever material is used for plugging the socket.

Adrenalin is generally kept in saline solution, to which chloretone (0·5 per cent.), a local anæsthetic and antiseptic, is added.

The drugs commonly used *internally* for hæmorrhage are lead, ergot, iron, and calcium. Lead in the form of the acetate combined with opium—*e.g.*, pilula plumbi cum opio ; ergot as the liquid extract (extractum ergotæ liquidum), or the injection (injectio ergotini hypodermici, ℥ 3 to 10). Ergot is conveniently prepared for subcutaneous injection from lamellæ (ergotin, grain $\frac{1}{3}$), dissolved in warm sterilized water, as solutions do not keep well; or the liquid extract may be employed. The injection should be intra-muscular, as the drug is an irritant.

The effect of ergot on hæmorrhage from the gums is not so pronounced as in hæmorrhage from muscular organs like the uterus, where the contraction of the unstriped muscle of the organ itself and that of its vessels helps in occluding their lumina. If used internally, it is best combined with perchloride of iron and dilute phosphoric acid, the latter for clarifying the bluish or greenish-black precipitate that results from the tannin contained in the ergot combining with the iron. Some flavouring ingredient should be added.

Iron is *incompatible* with all the vegetable astringents,

owing to the intense black precipitate formed on contact with substances containing tannic or gallic acid. It is also incompatible with alkalies and their carbonates.

The perchloride and sulphate are the forms in which the drug is generally used locally.

The perchloride of iron should be combined with sulphate of magnesium when given internally, or the sulphate of iron given with aloes in the form of a pill—*e.g.*, pilula aloes et ferri (grains 5 to 10). The magnesium and aloes overcome the occasional constipating effect of the iron salt.

The astringent taste of iron can be concealed with glycerine, and the drug thereby rendered easier to swallow.

The perchloride of iron should not be used as an injection, as the precipitated albuminate is liable to be carried off in the veins, cause embolism, and perhaps bring about a fatal termination.

The perchloride is valueless in hæmorrhage from internal organs, very little is absorbed, and that which passes into the tissues is already in proteid combination, and therefore incapable of assisting in the coagulation of blood.

Calcium should only be given in dilute solutions, as it is an irritant, and should be administered for two or three days previous to an operation up to a drachm of the liquor calcii chloridi in the twenty-four hours, but not pushed beyond this amount, or for longer periods. The action of calcium has been shown to have a *reverse effect* in large doses or after prolonged administration.

The soluble salts of calcium are of doubtful use in the treatment of hæmorrhage, except in some cases of hæmophilia, as they are only absorbed with difficulty.

Of the large proportion of lime taken into the body as food, only a small portion is absorbed, the rest leaving the body unchanged.

That which is absorbed probably enters into combination with the proteids of the body, and is slowly excreted, unless required by the tissues.

"The small quantity of calcium absorbed from the alimentary canal has not been shown to have any action, except in replacing the calcium compounds of the tissues."*

The calcium of the food is sufficient to supply the needs of the organism under ordinary circumstances, and any excess, as when lime salts are given as remedies, probably derives its activity from the acid radicle of the salt or anion, rather than from its calcium or ion.

Lime salts, however, are indispensable in some processes independent of the presence of living cells—*e.g.*, the coagulation of blood. The latter may be prevented by precipitating its calcium salts by oxalates.

Fibrin ferment is not formed except in the presence of calcium salts, but when once formed, lime salts are not necessary for the further formation of fibrin, for this will occur in oxalate solutions if fibrin ferment be added to fibrinogen (Hammerstein). "In other words, lime is not necessary for the activity of the fibrin ferment, but for its development from the prothrombin or zymogen, in which condition it exists in the circulating blood."† The prothrombin, or mother ferment, is believed to be derived from the white blood-corpuscles.

The part played by calcium salts in the coagulation of the blood may be graphically represented by the following formula:

Prothrombin + calcium salts (plasma) = thrombin (fibrin ferment);

Thrombin + fibrinogen = fibrin.

* Cushny, "Textbook of Pharmacology." † *Ibid.*

Clotting of blood starts from fine granular masses of protoplasm, derived from the white blood-corpuscles or from the blood-platelets. These masses under the microscope have the appearance of meshes in a net, the filaments representing the commencing clot.

Opium and *morphia* are useful in *allaying the restlessness* following upon the loss of large quantities of blood. These drugs are useful for intestinal hæmorrhage by retarding peristaltic movements, and so favouring the coagulation of blood. Their use would rarely be required for hæmorrhage from the mouth.

Escharotic drugs should be avoided, as they cause local gangrene and vascular dilatation of the surrounding area, and often increase, both in extent and depth, the area of the wound.

The *actual cautery* used at a dull red or black heat has much the same action as an escharotic, but as it can be applied more directly to the bleeding spot without its effects spreading to the same extent, it has not all the objections of the latter.

Both, however, are liable to be followed by secondary hæmorrhage when the sloughs separate, and more especially in the mouth, where asepsis throughout is difficult to obtain.

In hæmorrhage from bone, as from a tooth socket, the bleeding vessel cannot usually be picked up and ligatured, and should hæmorrhage continue after the above local measures have been applied, the treatment must be directed towards securing the bleeding vessel on its proximal side. The inferior alveolar canal has been successfully trephined, and the artery exposed and plugged.

If *plugging the inferior alveolar canal* is ineffective in controlling the hæmorrhage, or if the incontrollable bleeding is derived from the maxilla, further treatment must be directed to the common carotid artery.

Compression of this vessel at the sixth cervical vertebra will probably have been tried before the operation of plugging the inferior dental canal, and if compression has failed, *ligature* of this vessel would have to be considered.

After severe hæmorrhages, as those necessitating the ligation of a large vessel, the patient must be kept quiet in bed with his head low, the extremities firmly bandaged from below upwards, and the lower limbs raised off the bed. *Infusion* of warm saline solution either into a superficial vein or into the loose connective tissues will assist in maintaining the heart's action and in restoring the patient's strength.

CHAPTER III

EXTRACTION OF TEETH UNDER ANÆSTHESIA

Principles of extracting Teeth under Anæsthesia.

When performing the operation of extraction under an anæsthetic, we may have to *modify* to some extent the rules laid down for the process in general. As this has in the present day become a very important branch of dental surgery, we feel that we may with advantage devote a chapter to its consideration.

Before the anæsthetic is administered, the operator should decide what he *intends to effect*, and should take into consideration the fact that he may not be able to accomplish all he desires. Thus, a patient may be desirous of having three teeth removed, one of which has been causing pain. In such a case the one giving pain should, even though the least convenient to the operator for so doing, be first removed, for it would be distressing for the patient, on returning to consciousness, to find his enemy still in permanence, and circumstances might contra-indicate his taking an anæsthetic a second time.

If no tooth has been especially painful, we should, as a rule, remove *lower teeth before upper ones*, to avoid the blood interfering with our view; roots before whole teeth, and *back teeth before front ones*, for the same reason. If much has to be done, it is often desirable to confine the

operation to *one side of the mouth*, and to complete the operation on a subsequent occasion when the gums have partly healed.

In the preliminary examination of the mouth, every care should be taken to *avoid making the gums bleed*, or causing the patient pain or unnecessary fear. Yet the inspection should be conducted most thoroughly, so that the operator has a mental picture of the teeth or roots to be removed.

If many teeth are to be removed, it is a useful plan to have these *charted* on a slate or card, the latter for preference when a permanent record is required, or if the operation demands some subsequent visits for its completion. Notes can be made on this card if a tooth be fractured, or if there be doubt as to the existence of a root.

Masses of tartar likely to be dislodged during the operation should be removed, and the mouth rinsed with some efficient antiseptic, such as peroxide of hydrogen (10 volumes) or carbolic acid (1 per cent.). Cleansing of the teeth and gums should be commenced a few days previous to the extraction, when time permits.

The operator should next select his instruments, taking care to have not only those he is sure to use, but also any he may chance to require. These should be arranged in some *definite order* convenient to the operator himself; and it is a good plan always to adhere to the same order, whether few or many instruments be required. A fairly complete set comprises about ten instruments (Fig. 43), and in addition it is desirable to have duplicates of those most commonly used—*e.g.*, upper and lower root forceps—so as to be able to replace temporarily any which have become contaminated from pyogenic or other organisms. These can be conveniently set out in a metal instrument tray containing some antiseptic lotion (Fig. 57).

A mouth mirror, tweezers, and examining probe must also be close at hand, or kept in the same lotion.

Dry sponges or swabs of cotton-wool must be placed within reach, or held by an assistant.

It is desirable to have all instruments, appliances, and drugs likely to be required by the anæsthetist near at hand, in the event of any of them being omitted in his own portable equipment.

We recommend the operator, especially the less experienced, after the insertion of the prop, to take a view of the mouth from the position in which he will have to operate, to enable him to see the exact relationship of the teeth to one another and to the surrounding parts.

We recommend under the brief anæsthesia of nitrous oxide the employment of *as few instruments as possible*, as a few seconds wasted in the change of an instrument will often render a further administration necessary. This does not imply that we are to attempt at any time to use an unsuitable instrument. Those which we most frequently employ in such operations are the upper and lower root forceps, the form of hinge figured occupying the least amount of bulk (Figs. 23 and 27).

Besides limiting ourselves to as few instruments as consistent with safeness, the order of removal of teeth should be arranged as far as possible to *avoid unnecessary changes* of these.

Time should be economized in every possible way; thus the operator should be ready to take up his position as soon as the face-piece is removed, the instrument being left in the lotion up to this period.

The actual operating time should be spent in steady, sound operating, and cannot be hurried beyond a certain point. A little well done is preferable to more done in a

less satisfactory way, and the former will be rightly more appreciated by the patient.

Unless obvious signs are present indicating that the patient is regaining consciousness, it can be left to the anæsthetist to intimate when the operation should cease.

It is inadvisable for the student to attempt extractions under nitrous oxide anæsthesia until he has acquired considerable dexterity in operating without it, otherwise he will rarely become a safe, cautious, and dexterous operator.

Each tooth or root must be *removed from the mouth* before the operator attempts to extract others. An exception may be allowed where a tooth or root loose in its socket, or lying on the gum, remains firmly attached to the mucous membrane. This may be separated by scissors or lancet after the patient has regained consciousness.

If hæmorrhage be copious, the mouth and throat will require to be *sponged* out, and the head retained in a vertical position, or blood will trickle freely over the back of the tongue.

In extracting lower back teeth, care must be taken to avoid *pressing back the root of the tongue* or *depressing the jaw*, either of which are deleterious to an anæsthetized patient.

The conditions which render extraction of teeth under anæsthetics rather more difficult than otherwise are the following :

1. The patient's head must be more rigidly *kept in one position* throughout the anæsthesia—viz., that favourable for the anæsthetic used.

2. *Venous engorgement* occurring during anæsthesia, especially of the tongue and the floor of the mouth, may prevent a clear view of the teeth being obtained.

3. The importance of *preventing teeth from falling into the*

mouth during anæsthesia. If such occurs, they must be carefully removed before the operation is continued. In dealing with upper back teeth, it may be a wise precaution to keep a finger of the left hand behind the blades of the instrument, to form an inclined plane, down which the tooth will fall in the event of its slipping out of the forceps. Some operators use the corner of a napkin held with the left hand behind the tooth for a similar purpose. This would form a better protection than the first method, but would be cumbersome until the operator had accustomed himself to its use. The anæsthetist's spoon serves a similar purpose.

4. A mouth-prop or gag must be used to keep the mouth open, and in a small mouth this interferes to some extent with the available *space* for the introduction and manipulation of instruments.

The operation being completed, the patient's head should be pressed gently forwards, and a basin held under the chin.

There are two main reasons why failure at extraction occurs, even at the hands of those best qualified as operators. One of these is the *want of adaptability of forceps* for the variable conditions which present themselves, the other being the *relation of the roots of a tooth to the surrounding alveolus;* in some cases this may be of such a nature that it is a physical impossibility to deliver the roots intact. The necessary *haste* with which the operation has usually to be accomplished is a further difficulty to be overcome, and in this connection the operator is not always fair to himself in choosing an anæsthesia which is the safest and pleasantest for his patient. Nitrous oxide will not always allow sufficient time for a difficult extraction, and the operator may fail to carry out what would have been an

entirely successful operation had the duration of anæsthesia been adequate.

Patients should be informed that there is rarely difficulty in removing a tooth, provided the time for doing so be adequate, but that we cannot guarantee to carry out a difficult extraction during a prescribed anæsthesia of half a minute or so.

There is no reason why the operator should run the risk of failure, and frequently it is as much his own fault as that of his patient that he does so.

Fortunately, with continuous administration of nitrous oxide, ethyl chloride, and improved methods of inducing local analgesia, this difficulty has been to a large extent overcome.

Anæsthetics.

Anæsthetics may be divided into two main classes—viz., **General,** or respiratory, and **Local.**

The general anæsthetics usually employed in dental surgery are nitrous oxide, ethyl chloride, and ether, either by themselves or in various combinations.

Nitrous oxide is the most suitable anæsthetic for the majority of such short operations as those of extraction of teeth, being almost entirely free from danger, and allowing of a return to consciousness with but little discomfort and but slight after-effects. If either air or oxygen be administered with the nitrous oxide, a slight increase in the available anæsthesia is procured, amounting in the case of oxygen to about fifteen seconds.

The **choice of the anæsthetic** for extraction operations depends chiefly upon two factors—viz.: The *condition of the patient* and the *nature of the operation.*

1. The Condition of the Patient.

As far as the *age* of the patient is concerned, there are but few contra-indications to the use of nitrous oxide. In children only a brief anæsthesia can be obtained, but sufficient as a rule for the removal of one or more deciduous teeth.

Ether is not a suitable anæsthetic during childhood; it is very irritating to the delicate epithelial lining of their air-passages, and causes a profuse secretion of saliva and mucus, besides which the duration of anæsthesia obtained is not very prolonged. Ethyl chloride is a useful anæsthetic in childhood, when a longer and quieter anæsthesia than that obtained by nitrous oxide is required, but this advantage must be carefully weighed against its far greater lethal properties.

At the other extreme of life patients usually take nitrous oxide well, if administered with oxygen or air, although the health and vigour of the individual are more important factors than the actual number of his years.

Young adults and middle-aged people are usually good subjects for nitrous oxide anæsthesia.

The *sex* of the patient plays a part in so far as muscular development is concerned.

Female patients, if anæsthetized during a menstrual period, are prone to excessive bleeding from the operation wound, and during the induction of anæsthesia are liable to exhibit excitement and hysterical phenomena.

Nitrous oxide may be administered during pregnancy even in its later months, provided sufficient air or oxygen is administered with it to eliminate all signs of asphyxiation. The cyanosis and jactitation which characterize deep anæsthesia produced by nitrous oxide alone may involve also the uterine muscle, with the consequent risk of mis-

carriage, particularly in patients prone to abort. Local anæsthesia is better suited to these circumstances.

Ether, owing to its liability to produce coughing and straining, and to be followed by vomiting, is unsuitable in the later months of pregnancy.

It is undesirable to administer general anæsthetics during lactation, lest the secretion of milk be injuriously affected. Local anæsthetics will be less likely to have any harmful effect in this respect.

Patients suffering from *chronic bronchitis, asthma, emphysema*, or *advanced phthisis*, are bad subjects for anæsthetics, and need careful watching to prevent further embarrassment to their respiration and consequently increased strain on their heart and arteries. Nitrous oxide and oxygen may be administered to these people for short dental operations. Their condition, however, is apt to be aggravated after the administration, so that whenever possible local anæsthesia should be resorted to in these cases.

Patients suffering from *valvular disease* of the heart are liable to early and marked cyanosis under nitrous oxide, and grave risks may be incurred unless all asphyxial phenomena are eliminated and the pulse kept under strict observation. In the absence of an expert, these cases are better relegated to local anæsthesia. The colour of the patient's face, the character of his pulse and respiration, and the presence of signs of back blood-pressure, are the chief factors in determining how far compensation is maintained. Back blood-pressure is indicated by swelling of the legs and abdomen, œdema of the bases of the lungs, and general anasarca.

The presence of *aortic disease* or of a *fatty heart* are the most important cardiac lesions to consider when the administration of a general anæsthetic is contemplated. All general anæsthetics are dangerous under these condi-

tions, more especially those that throw much strain on the heart. Nitrous oxide is admissible only if given with oxygen by an expert. The patient should be anæsthetized in the recumbent posture, unless orthopnœa exists, in which case local anæsthesia alone is permissible. Unless struggling can be prevented and cyanosis avoided throughout the administration, the patient would be better advised to have whatever dental operation was contemplated performed under local anæsthesia, or should this be impracticable, a general anæsthetic should only be administered on consideration that the necessary operation would cause more shock if anæsthesia were withheld.

Frequent attacks of *syncope* associated with aortic disease or with a heart that has undergone degenerative changes are conditions that should prohibit the use of a general anæsthetic for dental purposes.

In congenital lesions of the heart, or malformations of the chest and air-passages, there is considerable risk in administering a general anæsthetic, and local anæsthesia should be selected in preference wherever possible.

Elderly patients, the subjects of arterial degeneration (*atheroma*) and its sequences, require great care, and the administration may give rise to much anxiety. In advanced cases of atheroma, local anæsthesia had better be substituted for general anæsthesia, on account of the danger of apoplexy, arising from the increased blood-pressure brought about by the latter or by the patient's struggles. Ether and undiluted nitrous oxide are in this respect injurious.

Aneurism, not infrequently a sequela of atheroma, requires the same care in its management. Anæsthetics which do not raise the blood-pressure—*e.g.*, local anæsthetics—are best suited in these cases; but nitrous oxide and oxygen may be given, provided anæsthesia is induced slowly, and cyanosis and struggling avoided.

Alcoholics and excessive smokers are "bad" subjects for the inhalation of any anæsthetic. Patients addicted to cocaine and morphia habits are likewise unsuitable subjects. In some cases of chronic alcoholism nitrous oxide is almost impotent for the purpose of producing anæsthesia. These patients merely become intoxicated by nitrous oxide, unless this be pushed to a degree involving dangerous asphyxial symptoms; they are prone to become noisy and to struggle violently. If anæsthesia be obtained, it is very brief, and is almost invariably accompanied by great muscular rigidity. Ethyl chloride by itself, or followed by ether, is the most satisfactory anæsthetic for these patients. Full doses of bromide of ammonium given for a few days preceding the administration will have a marked effect in quieting the patient. Recovery in these cases is often characterized by hallucinations, not infrequently of a pugilistic nature, and considerable tact is necessary in their management.

Very stout people are unfavourable subjects for the administration of any anæsthetic involving the delimitation of oxygen. Nitrous oxide should never be given without air or oxygen, as these patients rapidly become cyanosed, and frequently suffer from shortness of breath owing to a "fatty heart." Local anæsthetics are more suitable than inhalation anæsthetics for these people, as the former do not further embarrass the already impeded respiration.

Great care must be taken in anæsthetizing patients suffering from inflammatory *swellings in the neck—e.g.*, cellulitis (angina Ludovici)—as the danger of respiration becoming seriously embarrassed in these conditions is often far greater than might be anticipated from the clinical signs of the swelling. The use of nitrous oxide and ether is contra-indicated in these acute inflammatory conditions, as the glottis participates in the concomitant swelling and œdema,

and should the obstruction be further increased by the congestion induced by these anæsthetics, the serious embarrassment of respiration may endanger the patient's life. Moreover, the general toxæmia occurring in this condition involves the cardiac muscle and ganglia, thus lowering their vitality and rendering them less competent to withstand strain.

Thyroid tumour (goitre), lymphatic hyperplasia, and other forms of fluid and solid tumours of the neck, unless of small size, and producing no obstruction to breathing, contra-indicate the use of nitrous oxide or ether; and if a general anæsthetic is deemed advisable, the chloroform and ether mixture ($C.E_2$), by causing less congestion, will be the safest to employ. All forms of bag-inhaler are undesirable in these cases, and wherever possible local anæsthesia should be resorted to.

A good deal of attention has recently been ascribed to an obscure condition known as *lymphatism*, the *status lymphaticus*, or *thymicus*, owing to the fact that patients suffering from this affection are prone to sudden death from quite trivial causes.

For the signs and symptoms of this disease the reader is referred to the author's work on anæsthetics.*

Scarcely more than a tentative diagnosis can be made, but sufficient evidence may be present to warrant the anæsthetist in employing every precaution, both in the choice of the anæsthetic and in its administration. The slightest interference with respiration must be avoided, and a complete, although not a deep, and uniform anæsthesia maintained throughout.

Ether and nitrous oxide are contra-indicated if obstructive conditions are present, and if employed under less critical circumstances, must be administered with free supplies of air and oxygen respectively.

* "Anæsthetics in Dental Surgery," by Coleman and Hilliard.

Chloroform and ethyl chloride are undesirable in this disease. Ether administered by an open inhaler is probably the least dangerous method of anæsthesia to employ.

2. The Nature of the Operation.

The number and the condition of the teeth, their position, and the state of the mouth, must be taken into consideration in deciding what anæsthetic to employ.

One to four teeth, presenting no special difficulties, can usually be removed under a single administration of nitrous oxide.

The prolonged nasal administration of nitrous oxide will provide the most satisfactory anæsthesia in adults, when sufficient time is the only desideratum for the extraction of several teeth presenting no special difficulties. But when a similar operation has to be performed upon a child, the administration of a single dose of ethyl chloride is preferable. Children are not good subjects for the prolonged administration of nitrous oxide. They bear deprivation of oxygen badly, and under nitrous oxide become quickly cyanosed, exhibiting early jactitation, and, unless only a light degree of anæsthesia be maintained, they are prone to develop opisthotonos.

For a difficult extraction—for instance, an impacted lower wisdom tooth, more especially if this be accompanied with trismus—nitrous oxide combined with ether is usually the best anæsthetic to employ. The anæsthesia obtained by this means will allow the operator to have full control of the patient's head; the muscles become relaxed, and thus the jaws can be more readily separated than under a nitrous oxide anæsthesia.

Should ether cause much salivation and secretion of mucus, or fail to produce an available anæsthesia of sufficient duration for the operation, the administration may

be continued by the alcohol, chloroform, and ether mixture (A.C.E.), or by chloroform administered by a Junker's apparatus and mouth-tube, provided the patient be placed in the recumbent posture.

The anæsthetist should inquire of the dentist what duration of anæsthesia is likely to be necessary, and the anæsthetic to be employed must be selected accordingly.

When there is some doubt as to the difficulty of any given extraction, the operator should choose an anæsthetic which does not bind him to a limited duration of anæsthesia, but one that can be continued, if necessary, to meet the requirements of the case.

Preliminaries to an Administration.

Before commencing to anæsthetize a patient, it is necessary to see that the apparatus and drugs to be used are efficient, and that accessory requirements are at hand—*e.g.*, a *mouth-gag*, *wooden mouth-opener*, *mouth-props*, *sponges and their holders*, *tongue forceps*, *hypodermic syringe*, *strychnine*, *adrenalin* (0·1 per cent.), and ampoules containing *amyl nitrite* and *pituitary extract;* also a *stethoscope*, a *tracheotomy case* containing a tracheotomy tube, scalpel, small retractors, dissecting and artery forceps, blunt hooks, and a tracheotomy dilator (two-bladed). *Oxygen*, which will often be on the premises, forms a useful restorative in some cases of respiratory failure.

The anæsthetist should always have ready the means for administering one of the more powerful anæsthetics in the event of nitrous oxide proving inadequate.

The anæsthetist should make himself acquainted with the *procedure of the operation*, so that he will know when and where a gag is likely to be wanted. He should also anticipate any assistance that the dentist may require, such as altering the position of the patient's head, in-

creasing the amount of space for working in, or introducing a mouth-gag. In the extraction of teeth, the dentist should, as far as possible, keep to an orderly method of working; he should remove lower teeth before upper teeth, back teeth before front teeth, and confine his attention to one side of the mouth before proceeding to the other side.

Attention should next be directed to the patient's comfort, adapting this as far as possible to the needs of the operator and the anæsthetist. It is assumed that the patient is already aware that an anæsthetic is to be administered, and that at least two hours have elapsed since his last meal.

The bowels should be emptied on the morning of the anæsthetic, or on the previous day if the patient is irregular in this function and requires a purgative, and the bladder emptied shortly before the administration commences.

For anæsthetics other than nitrous oxide, the régime should commence a day or two previous to the operation.

A wine-glass of port wine or a small quantity of brandy and water may be allowed, if the patient be in delicate health or accustomed to a stimulant between meals. This should preferably be taken at the patient's habitual time, or half an hour previous to the administration. The effect of this in weakly patients is undoubtedly to temporarily invigorate their constitution, and a nervous patient will become more resigned to, and feel less agitated by, any impending operation.

All tight clothing, such as corsets, belts, and collars, should be loosened, so that the chest, abdomen, and throat may be in no way impeded during respiratory or possibly struggling movements. Tight corsets and bands round the waist prevent full descent of the diaphragm, and consequently the interchange of gases in the lungs.

The *position of the patient* must be that which favours

a satisfactory anæsthesia, and such as can, if necessary, be altered during unconsciousness to meet the requirements of the operator.

For a nitrous oxide or ethyl chloride administration, or a short inhalation of ether, the patient should sit well back in the chair, with the spine erect and the head and

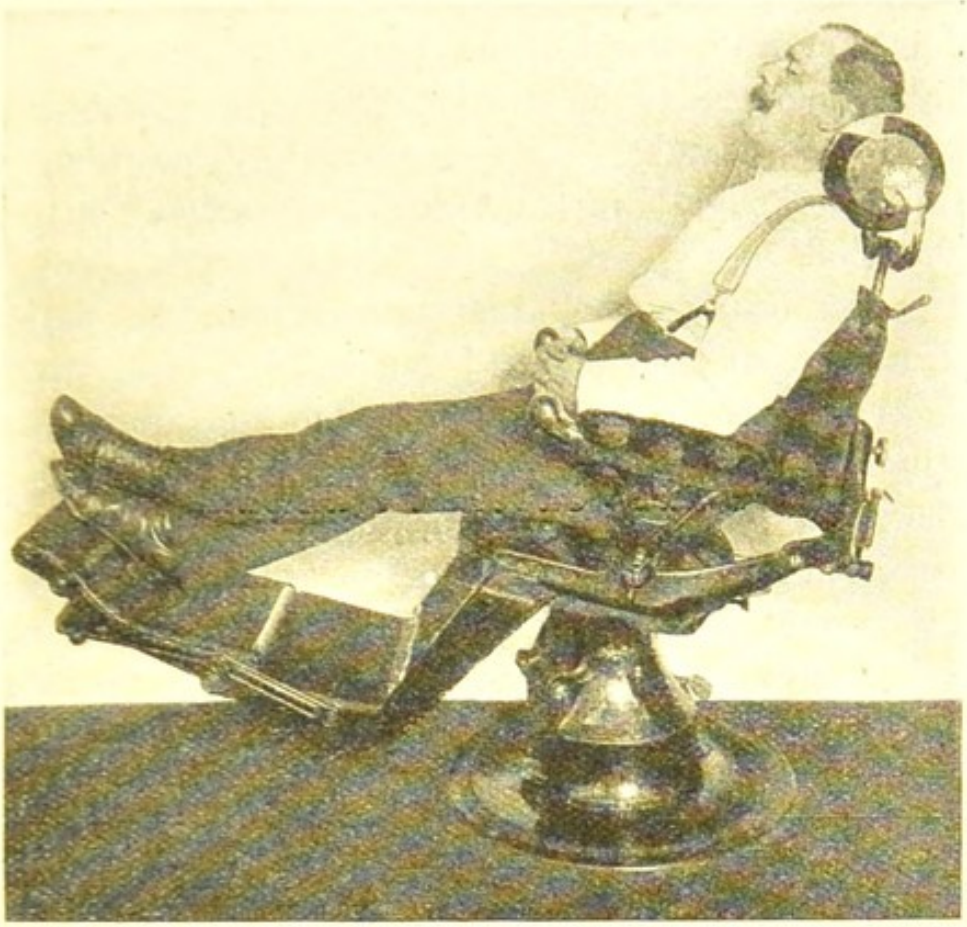

FIG. 53.—POSITION OF PATIENT FOR AN ADMINISTRATION OF NITROUS OXIDE. (COLEMAN AND HILLIARD.)

neck in a line with the body. The floor of the mouth should assume a nearly horizontal plane, which can be raised or lowered by movements conveyed to the chair (Fig. 53).

The posture should be one of muscular relaxation, and free from restraint. There should be no foot-piece or other obstacle about the operating-chair which may cramp

the body and allow of leverage with the feet and legs should struggling movements ensue.

The objectionable foot-rest may be rendered serviceable if it be utilized for raising the patient's feet in a line with his pelvis, the heels alone resting on the rail of the foot-rest. In this position it is almost impossible for a patient to slip down into the chair during the anæsthesia, and his feet are well out of the operator's way.

For a prolonged administration of ether the patient should assume the recumbent or semi-recumbent position, with the shoulders slightly raised, so that the head may be turned to one side.

An apron or towel should be fastened round the patient's neck to prevent the clothing being soiled.

The room should be suitably heated and appropriately ventilated.

The mouth should be opened, and a glance taken in it to ascertain its contents. Any denture should be removed, and the presence of artificial crowns, loose teeth, loose roots, or other impediments to the insertion of a prop or gag, should be noted.

The prop should always be fixed to a chain or cord which hangs out of the mouth, and its free end attached to another prop or cork. Whenever possible the prop should be placed on the side of the mouth opposite to that on which the operation is to take place, and preferably behind the premolar region, or no farther forward than the canine teeth. If the teeth to be removed are in the front of the mouth, the prop is less in the way of the operator if placed on the patient's left side. The mouth should be well opened, but at the same time not stretched to the utmost, or this will make the masseters taut and render the cheek rigid. If the prop can be so placed as to obviate the use of a mouth-gag, this is desirable, as time is econo-

mized during the anæsthesia, and the anæsthetist's hands are free for steadying the patient's head. The patient is now requested to bite on the prop and close his lips; this renders the prop more secure, and allows the adaptation of the face-piece to be more accurate.

If the patient has difficulty in opening his mouth on account of inflammatory œdema of the masseteric and pterygoid regions (trismus), either a gag must be inserted from the beginning and the face-piece adapted as well as possible over it, or the teeth must be separated by a small prop, which will allow sufficient space for the subsequent introduction of a gag during anæsthesia.

The mouth can almost invariably be opened sufficiently wide to allow a small prop or a closed gag to be inserted, and only failing this is it permissible to commence the administration with the teeth clenched.

If it is found necessary to open the mouth during the anæsthesia, the teeth may be slightly separated by means of a wooden wedge forced between firm back teeth so as to allow space for a gag to be inserted. The wedge should be employed, when possible, on the opposite side to which the gag is required.

The patient's friends should be requested to wait in an adjoining room, and only by expressed desire should they be allowed to remain in the same room. When this permission is granted, they should be previously warned that the patient while under the influence of nitrous oxide may present an unpleasant appearance, or perhaps struggle and become noisy.

For the administration of an anæsthetic, the reader must consult a work on the subject.

Difficulties and Dangers of Tooth Extraction during Anæsthesia.

The difficulties and dangers arising during the operation period are associated both with the operation and with the anæsthesia. In carefully following out the ordinary rules for the extraction of teeth, and those for administering an anæsthetic, accidents of all kinds can to a large extent be avoided. A tooth may drop from the forceps on to the root of the patient's tongue. Should this occur, the head must be immediately bent forward, and the operation discontinued until the tooth is recovered. Any attempt made to dislodge the tooth from this position with the finger may induce a deep inspiratory effort, resulting in the tooth passing down the air-passages.

When, however, the tooth lodges on the floor of the mouth or sulcus of the cheek, the finger may be swept round behind it, and the foreign body brought to the front of the mouth and removed, the head being held forward during these manipulations.

Blades of forceps, props, and gags may break, and any of these may pass over the back of the tongue through the isthmus of the fauces, and partially or completely obstruct the air- and food-passages.

Foreign bodies of the above nature are not likely to cause complete obstruction, as in the case of a bolus of food impacted at the entrance of the gullet; although, if unrelieved, inflammation would rapidly ensue, causing œdema of the glottis, with complete blockage.

Obstruction to the Food-Passages.—If the foreign body remains impacted in the *pharynx*, the mouth must be widely gagged open, and the finger thrust to the back of the pharynx, the foreign body sought for and removed. If this fails, a further attempt should be made with

suitably curved forceps, aided by a good light. In most of these cases the nature of the foreign body will be known.

When asphyxial symptoms are urgent and increasing, the air-passages must be immediately opened; and after the patient has been given relief, further attempts made to remove the foreign body.

Inversion, together with vigorous shaking of the patient, has been effectual in dislodging a foreign body, and should be tried both before and after opening the air-passages.

A heavy, smooth body, such as those mentioned, would in most cases find its way into the *œsophagus* and may become lodged in some part of its course, giving rise to a fixed pain, aggravated by swallowing or coughing. Some amount of dyspnœa would be present, varying with the position and size of the object. The foreign body may be spontaneously ejected into the mouth, or pass into the *stomach*.

An emetic, such as the subcutaneous injection of apomorphine hydrochloride ($\frac{1}{6}$ grain), may be permitted when the foreign body is known to be small and smooth (Cheyne and Burghard). Previous to the injection the practitioner should allow the patient to drink a glass of water, otherwise an empty stomach may simply contract on the foreign body.

The most common situations for foreign bodies to become arrested in the œsophagus are at its two extremities and where it is crossed by the aorta—*i.e.*, the narrow parts of the canal. Should they safely negotiate these places, the pyloric end of the stomach is the next position likely to offer resistance.

Provided no further symptoms arise, the foreign body may be allowed to pass naturally. The patient should be kept quiet for a few days, and take food of a pultaceous consistency.

Obstruction to the Air-Passages.—Teeth are the most likely of the above-mentioned foreign bodies to pass into

the *larynx*, excluding blood, pus, and saliva. If causing total obstruction, death may result, unless treatment be very prompt.

Partial obstruction is evidenced by a sudden sense of suffocation, marked cyanosis and dyspnœa, violent spasmodic coughing, and alteration in the voice.

During one of these expiratory spasms the foreign body may be ejected into the mouth; if not, immediate preparations must be at hand for performing laryngotomy. An attempt is then made to bring the foreign body out through the laryngotomy wound, or to dislodge it into the buccal cavity. A small, light body—*e.g.*, portion of a tooth—may become lodged in the ventricle of the larynx. This will be indicated by the shortness of the intermissions between the attacks of spasmodic coughing, and requires for its treatment a high tracheotomy or laryngo-tracheotomy, followed by dislodgment of the foreign body from below.

If the foreign body becomes lodged in the *trachea*, it may shift its position with respiratory movements, causing spasmodic and urgent attacks of coughing, associated with dyspnœa. An extensive low tracheotomy should be performed, and the edges of the wound kept well open, in the hope of the foreign body being expelled during an attack of coughing.

Should it have passed into one of the *bronchi*, it will give rise to a dull pain behind the sternum, associated with shortness of breath, cough, and diminution of breath sounds; later, collapse of that portion of the lung supplied by the affected bronchus, with dulness over a corresponding area.

The right bronchus being the larger, and the spur formed at its commencement deflected to the left of the middle line, is consequently more often the recipient of foreign bodies.

Irritation and inflammation follow the retention of a

foreign body in a bronchus, and an abscess has been the means by which a foreign body has become loosened and expelled during a fit of coughing, or recovered externally by the empyema making its way towards the chest wall.

Within recent years a direct method of diagnosing and removing foreign bodies from the air- and food-passages by bronchoscopy and œsophagoscopy respectively has been advocated, and many successful cases have been reported.* For these methods to be successful it is important to undertake the extraction of the foreign body at an early period.

For the technique of these operations and the treatment of foreign bodies impacted in the food- or air-passages, the reader is referred to some work on surgery, as only the emergency treatment for these conditions can here be referred to.

Should the operator depress the jaw, force back the tongue, or unwittingly obstruct the air-passages in other ways while extracting teeth, the patient will become cyanosed, especially if the obstruction occurs directly after the removal of the face-piece, or during a continuous administration of nitrous oxide.

This temporary cyanosis will usually pass off on allowing the patient one or more full breaths of air, and the operation may then be resumed.

Loosening or Dislodgment of a Tooth.—A tooth may be loosened or dislodged in introducing a gag. Unless the tooth was previously loose, this is generally an avoidable accident, and usually results from the gag not being inserted sufficiently carefully, or having been placed in the front of the mouth. By inserting a gag in the front of the mouth, one or more of the incisor teeth may be splayed out or entirely dislodged from their sockets, and a similar

* D. R. Paterson, *British Medical Journal*, August 18, 1906, and February 8, 1908.

accident may occur through the use of a central prop. The loosened or dislodged teeth must be immediately reinstated, in the latter case after being cleansed.

The insertion of a gag may also be responsible for *bruising of the lips, gums, or other adjacent soft parts.* The first of these accidents usually occurs through the lower lip being insufficiently depressed before the introduction of the gag. The lip gets carried over the lower teeth, and crushed on these when the gag is opened.

Another accident attendant upon extraction of teeth, more especially under anæsthesia, is *dislocation of the mandible* (p. 79).

Local Analgesia.

The term analgesia implies a loss of sensation to painful stimuli without the production of loss of consciousness. Analgesia is a more accurate term than anæsthesia, for in many cases tactile sensation is not completely lost, although pain in the same area is abolished.

The improved technique of producing local analgesia has been largely responsible for the advances made in this form of anæsthesia. In dental practice, local analgesia is capable of being put to many purposes, and has the prospect of further increase in the future, but it is not yet destined to displace general anæsthesia.

The mucous membrane of the mouth responds to the four varieties of sensation—viz., those of *pain*, *pressure*, *heat*, and *cold*. The sensory nerves supplying the teeth and gums are derived from the fifth cranial nerve, and the terminations of this nerve or its main branches must be intercepted on their course to the basal foramina, by mechanical, by chemical, or by thermal agencies, if a paralysis of their conducting power is desired.

Action of Local Anæsthetics.

Before mentioning the various ways in which local analgesia may be obtained, a preliminary note on the present views held of the action of local anæsthetics may serve a useful purpose.

Local anæsthetics are chemical compounds, and as such are employed usually in weak solutions. The contained drug, when brought into contact with sensory nerves, paralyzes, but causes no permanent injury to them. This effect is dependent upon the presence in these agents of certain atom groups, designated by Ehrlich as anæsthesiphorous atom groups. It is probable that these atomic groups enter into certain *chemical combinations* with the protoplasm of the nerve substance, and the nerve remains paralyzed until the newly formed compounds are split up and the poison eliminated by the circulating blood.

M. Chevalier* suggests that the action of a local anæsthetic may be due to an incomplete and transient *coagulation of the albuminoids*, causing a modification in the osmotic tension of the cellular fluid. In this way the normal functions of the protoplasm are suspended; thus the sensory nerves lose their power of conveying sensation, those endowed with motor and trophic functions are temporarily incapacitated, and tissue-respiration is modified.

All local anæsthetics should be *isotonic*—that is, of equal osmotic pressure to that of the tissues—or the tissues with which they come into contact will be injured.

A solution that causes neither swelling nor shrinking of the red blood cells is said to be isotonic. All isotonic solutions possess the same freezing-point, which corresponds to that of the blood—viz., 0·56° centigrade. The

* *Lancet*, November 27, 1909, p. 1647.

isotonicity of a solution can therefore be determined by observing the behaviour of a red blood cell when brought into contact with the solution, or by obtaining its freezing-point.

Solutions can be rendered isotonic by the addition of any of the indifferent salts of sodium—*e.g.*, the chloride, sulphate, phosphate, and carbonate. The solutions employed must be at the body temperature when injected, or they will act as protoplasmic poisons.

A physiological (*i.e.*, isotonic) solution of sodium chloride at the body temperature contains 0·92 per cent. of sodium chloride.

A *hypotonic* solution, or one that contains less than its complement of salts, gives off water to the tissues and takes up their salts, thereby causing swelling of the tissue cells and alteration in their structure.

A *hypertonic* solution, or one containing more than its complement of salts, abstracts water from the tissues, and the latter abstract the salts from the solution, thereby increasing the ratio of salts in the tissues, and causing the tissue cells to shrink and become crenated.

Inflammation or gangrene may result from the injection, if the freezing-point of the anæsthetic solution be sufficiently remote from that of the blood. The subcutaneous injection of a 0·92 per cent. solution of sodium chloride at the body temperature produces a raised white wheal, which is unattended by pain or alteration in sensation, and which disappears completely within a few minutes; whereas the injection of pure water, or any solution that is not isotonic, is accompanied by pain. Solutions that are not isotonic are protoplasmic poisons. The temporary paralysis of sensation following the injection of a hypotonic or hypertonic solution results from direct injury to the nerve cells. If the percentage of salts required to pro-

duce an isotonic solution be diminished or increased, the pain caused by their injection will vary in a like ratio with the departure from isotonicity.

The efficiency of a local anæsthetic solution is ascertained by noting the quantity required to render anæsthetic a wheal produced by an isotonic solution of sodium chloride, and by observing the duration of anæsthesia so obtained. The production of inflammation and pain are indications that the agent employed is injurious to the tissues.

Methods of producing Local Analgesia.

Local analgesia for the extraction of teeth may be obtained in the following ways:

1. Drugs painted or sprayed over the area desired to be rendered insensitive (*superficial* or *surface anæsthesia*).
2. Drugs which, by extracting heat from a part, cause a contraction of the underlying vessels, and thus indirectly interfere with the nutrition of its contained nerve-fibres (*terminal anæsthesia*).
3. Drugs injected into the area for operation (*infiltration anæsthesia*).
4. Drugs injected into or around the nerve trunks supplying the operative field (*regional* or *conduction anæsthesia*).

1. **Superficial anæsthesia** is obtained by drugs, known as local anodynes, which produce their desired effect by depressing the termination of sensory nerves. Prominent among these are cocaine, aconite, carbolic acid, and menthol. Opium has but very feeble anæsthetic properties when applied locally to inflamed parts. Some of these drugs in stronger solution have an escharotic action (*e.g.*, carbolic

acid), and then come into the category known in dental surgery as obtundents.

When it is necessary to produce only a superficial anæsthesia of the mucous membrane, drugs such as cocaine and its salts, or any of the drugs commonly injected used in stronger solutions, will usually suffice.

2. **Terminal anæsthesia** results from the action of an anæsthetic upon the terminal branches of a sensory nerve, probably owing to paralysis of their end-organs, and as an example of this the application of a freezing mixture may be quoted. Terminal anæsthesia may also be produced by a peri- or intra-neural injection of a local anæsthetic. The condition produced is similar to that of a frost-bite, the vaso-constriction of the arterioles producing a temporary paralysis of the nerves traversing the frozen area, owing, no doubt, to the poverty of their nutrition.

Drugs, the evaporation of which causes such intense cold that the parts subjected to their influence become bloodless and so lose their sensibility, are occasionally brought into use for this purpose—*e.g.*, ether, the chlorides of ethyl and methyl. The anæsthesia, however, is superficial and transient, applicable only to a few cases, and produced in these with some amount of discomfort.

Method of Application of Refrigerating Agents.

(1) The gums should be dried, and the area to be rendered insensible shut off as far as possible from the surrounding parts by a cloth, cotton-wool, or other suitable material.

(2) The spray should be conveyed in a small jet, and continued until the gum is blanched on both sides, and over an area well beyond that occupied by the tooth. The gum should remain in this bloodless condition for a few seconds before the spray is discontinued.

The operation must be quickly carried out, and if an

assistant is available, the spray may be continued during its progress. The method is not applicable if a difficult extraction is anticipated, or in proximity to an inflamed periosteum, sensitive dentine, or an exposed pulp. Under these conditions, which are those for which teeth are usually removed, the access of cold would give rise to acute pain. For single loose teeth or roots the method may be employed, but it presents no advantages over other methods.

In some of the cases in which ethyl chloride has been employed locally in the form of a spray, sufficient of the vapour has without doubt been inhaled to produce a general effect.

(3) **Infiltration anæsthesia** is obtained by filling or saturating the tissues with an anæsthetic, regardless as to the position of the nerve trunks, thus paralyzing all the sensory nerves in the contained area, in contrast to regional anæsthesia, where the area for operation is rendered analgesic by one or more peri- or intra-neural injections. Infiltration anæsthesia annuls the transmission of sensory impulses in the nerves which traverse the infiltrated area, whereas regional anæsthesia cuts off their transmission to the higher centres in the brain at a point corresponding to the site of injection, so that sensory paralysis follows in the nerve-distributing area below this level.

In general surgery a combination of both methods is often advantageous, whilst in dental surgery infiltration anæsthesia is that usually employed.

(4) **Regional** or **conduction anæsthesia** is the term applied to that form of anæsthesia which results when the conducting power of a sensory nerve is inhibited in some part of its course from the periphery to the brain or spinal cord. The nerve conduction to the brain or spinal cord, as the case may be, is cut off at the site at which the anæsthetic is introduced.

Regional anæsthesia is procured by means of a peri- or intra-neural injection of a local anæsthetic. This method is applicable only to nerves which can be accurately located from the surface, easily reached by the needle, and not in the vicinity of important structures. Peri-neural injection is sometimes applied to the inferior alveolar nerve as it enters the inferior alveolar foramen. The needle of the syringe is inserted behind and about half an inch above the upper surface of the third lower molar, and, thence guided by the feeling of the bone, is carried to the outer side of the lingula at the orifice of the inferior alveolar canal. The needle must be kept close to the bone after penetrating the mucous membrane at the anterior border of the ascending ramus, and the fluid can be injected as the needle is slowly pushed onwards for an inch or so. The lingual nerve, owing to its proximity, is not infrequently involved in anæsthetizing the inferior alveolar nerve.

In making deep injections in the proximity of large vessels, the needle should first be introduced while attached to an empty syringe, and if, on withdrawal of the piston, little or no blood appears in the barrel, the syringe may be disconnected from the needle, filled with the anæsthetic solution, and reattached to the needle. The contents of the syringe may then be discharged into the tissues with but little risk of injury to any important vessel.

For intra-neural injection the nerve is first rendered insensitive by infiltration analgesia; some of the solution employed is then injected directly into the nerve trunk. This has the effect of causing an instantaneous dissolution of its conducting power, and producing an anæsthesia of about half an hour's duration.

Intra-neural injection is liable to be followed by a fatty degeneration of some of the nerve fibres, as shown by V. Lier in the case of the sciatic nerve in rabbits, whereas

peri-neural injections of the same solutions produced no degeneration. Crile's experiments showed that an intra-neural injection produced an anæsthesia of less duration than that of a peri-neural injection, so that the former method seems to possess no advantages over the latter.

Qualities of Drugs Necessary for Local Injection.

Drugs intended for hypodermic injection must be capable of fulfilling certain conditions, and these are:

1. An *analgesic power* equal to, or not far removed from, that of cocaine.
2. *Sterile*, or capable of being rendered so by thermal changes (*i.e.*, boiling).
3. Free from substances likely to cause local irritation, or produce general toxic effects. This statement necessarily implies that the solution must be *isotonic*.
4. The composition and the quantities of the *ingredients must be known*.

Other desirable qualities are that the drug employed should be compatible with adrenalin chloride, sufficiently soluble in water to form a 2 per cent. solution, and that it should possess the property of rapid diffusion in the tissues.

The drugs most commonly used are: *cocaine*, *beta-eucaine*, *stovaine*, and *novocaine*. Others less frequently employed are *tropa-cocaine*, *alypin*, *nirvanin*, *anæsthesin*, *acoine* (hydrochloride), and *holocaine* (hydrochloride).

Cocaine is an alkaloid obtained in the form of a white crystalline powder, soluble in water and alcohol. The hydrochloride is the salt most commonly used for local injection.

The action of cocaine is first to excite and then paralyze,

but the latter is accompanied by certain disadvantages which have limited the use of this drug.

Cocaine has a greater affinity for the sensory than for the motor nerves; it is a vaso-constrictor, but the addition of adrenalin chloride produces a further constriction of the vessels.

The sensory phenomena are abolished in the following order: light touch, temperature, pain, and pressure; after these the motor faculty becomes impaired. This order is reversed during recovery from the poisoning, motion being the first of the faculties to be regained.

Solutions of cocaine and other soluble local anæsthetics should be prepared from distilled water, and the sodium chloride (0·9 per cent.) added before boiling, or a standardized saline solution employed. If solutions of cocaine are kept for a long period, or heated to boiling-point, the drug is apt to be converted into the inert alkoloid ekgonin. Solutions must be therefore freshly prepared, and not subjected to prolonged or repeated boiling.

One c.c. of a 1 per cent. solution of cocaine will usually be sufficient for tooth extraction in an adult; this amount is equivalent to employing 1 centigramme of cocaine ($\frac{1}{6}$ grain). At the extremes of age one-half of this dosage may suffice.

Beta-eucaine is a synthetic compound, and although not so efficacious as cocaine for producing analgesia, it is less toxic, and can be rendered sterile by boiling. The hydrochloride and the lactate are the salts usually employed; the latter has the advantage in being more soluble than the former in the proportion of 7 to 1. It is slightly irritant and a vaso-dilator, so lessening the vaso-constrictor effect of adrenalin chloride. β-eucaine is not sufficiently soluble in cold water to produce a 2 per cent. solution, but on warming a solution of this strength can be readily obtained.

A-eucaine is no longer used, owing to its irritating properties.

Stovaine (hydrochlorate of amylene) is a white crystalline powder produced from tertiary amylic alcohol. It is freely soluble in water. Its solutions are acid in reaction, and liable to cause inflammation in the area of injection, or, if containing 5 to 10 per cent. stovaine, may produce gangrene. Solutions of stovaine can be boiled without decomposition. The drug has a vaso-dilator effect, which is not overcome by the constricting effect of adrenalin chloride. Its analgesic and toxic properties approach those of cocaine in their intensity; in fact, it is stated to be a more powerful anæsthetic, weight for weight, than cocaine. Stovaine has been employed in surgery, chiefly in connection with spinal analgesia.

Novocaine (hydrochloride of para-amido-benzoyl-diethyl-amino-ethanol) was discovered by Einhorn as a synthetic compound derived from the amido-benzoic-acid series. It is a white crystalline powder, freely soluble in water (1 : 1), and forming a neutral solution, which can be rendered sterile without decomposition. Novocaine is a non-irritant, and its toxic properties do not appear to be pronounced. Reclus* states the toxic properties of novocaine to be half those of stovaine and four times less toxic than cocaine. Unlike stovaine, a 10 per cent. solution of novocaine may be injected without producing pain or irritation, although a solution of this strength is rarely required. The local effect of novocaine is intensified and prolonged by combination with adrenalin chloride. Novocaine complies the most favourably of all the local anæsthetics with the essential qualities of an ideal anæsthetic (p. 143).

Novocaine is incompatible with alkalies, and as this applies to some of the other local anæsthetics, a separate

* *Lancet*, July 18, 1908.

sterilizer should be kept for the purpose of preparing the syringe and needles.

Tropa-cocaine (benzoyl-pseudo-tropine) was obtained by Giesen in 1891 from the Java coca leaves, and a year later was synthetically produced by Liebermann. Tropa-cocaine produces an anæsthesia less intense and more transient than that of cocaine. It is soluble in water, and its solutions can be boiled without decomposition. The drug is slightly irritant to the tissues, but is said not to depress the heart. Tropa-cocaine is antagonistic to adrenalin chloride, so that the addition of the latter does not increase its analgesic power.

Alypin is a synthetic compound closely allied to stovaine in its chemical formula. It is a more toxic drug than cocaine in the ratio of 1·25 to 1, and is somewhat irritating to the tissues. Its anæsthetic power is enhanced by the addition of adrenalin chloride.

Nirvanin is soluble in water, and can be sterilized without reducing its activity. Its anæsthetic properties are inferior to those of cocaine.

Anæsthesin is almost insoluble in water, and is endowed with no special property to commend it in place of those anæsthetics already mentioned. The same applies to *Acoine* and *Holocaine*.

Adrenalin chloride as a coadjutant of the above-mentioned drugs requires some description as to its properties.

Epinephrine or adrenalin,* the active principle derived from the suprarenal glands, was first isolated by Abel. Adrenalin is a poisonous alkaloid; the commercial preparation is composed of a solution of hydrochloric acid made *in vacuo*, and containing 0·1 per cent. adrenalin chloride.

* Other names applied to this substance are adrenine, suprarenine, suprarenaline, vaso-constrictine.

It should be kept in ruby-coloured bottles, carefully stoppered, as it readily decomposes on exposure to light and air. The drug is the active principle of the suprarenal gland, and is obtained by making a watery extract from the dried glands of the sheep or ox. The solution may be sterilized by boiling.

More recently adrenalin has been prepared synthetically, and the manufactured article possesses equal vaso-constrictor properties and greater stability, being unaffected by light or by boiling when in dilute solution. When added to a solution of eucaine, the synthetic product undergoes the same colour change as does the ordinary adrenalin solution.

Adrenalin causes a marked *rise in arterial blood-pressure* when injected into the circulation, accompanied first by acceleration, then slowing, and finally again by acceleration of the heart. This rise of blood-pressure is largely due to constriction of the vessels of the abdominal cavity, produced by the direct action of the adrenalin on the muscle of the vessel walls, or on the nerve terminations in them, as it occurs after destruction of the vasomotor centre, or after section of the splanchnic nerves and paralysis of the ganglia on the vasomotor constrictor nerves.

The acceleration of the heart is due to stimulation of the terminations of the accelerator nerves in the heart muscle; the acceleration later gives place to a slowing of the heart, owing to excitation of the vagus centre by the increased blood-pressure, as it is lessened on section of the vagi, and disappears under atropine. Finally, the vagus centre becoming exhausted, the blood-pressure begins to fall, and the accelerator stimulation again comes into prominence, with the result that the heart contractions are quickened.

The effect of adrenalin on the heart and vessels is somewhat similar to that of digitalis, and its action is probably

both on the medulla and directly on the muscular coats of the arterioles. The former is indicated by the slowing of the pulse, and the sustained and strengthened systole of the heart; the latter by the marked contraction of the peripheral arterioles. The action of digitalis, however, is slower in its onset, more prolonged in its effect, and of less intensity.

The action of adrenalin on the arterioles is well seen in perfusing a mixture of blood and the extract through the vessels of an excised organ; the mixture passes through the organ and escapes less rapidly than when blood alone is perfused. The marked contraction of the vessels of a mucous membrane (*e.g.*, conjunctiva) or of the mesentery when adrenalin is applied directly to them is a further illustration of its vaso-constrictor properties.

Adrenalin has no action on the unbroken skin or on organs without a sympathetic nerve-supply—*e.g.*, the lung and brain—consequently, when adrenalin is injected, these organs become congested to relieve the circulation in other parts.

Those secretions under sympathetic control (*e.g.*, the saliva) are affected by adrenalin.

Adrenalin causes contraction of some forms of unstriated muscle and relaxation of others, the character of the response being determined by the nature of the normal impulses transmitted by these nerve fibres—*e.g.*, inhibition of the peristaltic movements of the stomach and intestine, and contraction of the pyloric, ileo-colic, and internal anal sphincters. This peculiar action of adrenalin in producing either contraction or relaxation of unstriped muscle seems to indicate that its action is not directly on the muscle fibres, and as its effects correspond closely to those of sympathetic stimulation, it has been inferred that it influences the nerve terminations in the muscle. This view,

however, is invalidated by the fact that the action of adrenalin persists after the degeneration of these nerve terminations or endings, unless it be assumed that the "myo-neural junction," the locality at which the adrenalin acts, does not degenerate.

The short duration of the effect of adrenalin on blood-vessels has been ascribed to its rapid excretion or oxidation, but this view is not supported by its continued action when allowed to enter a limb previously occluded by ligature, and after its effect had passed off in those parts in which it had previously circulated.

Adrenalin, when injected subcutaneously, causes blanching of the tissues by contracting their contained arterioles, and its effects remain local.

When combined with alkaloids, such as cocaine, it retards their absorption, and so prolongs their local effect; thus sensation is suspended for over two hours when a solution of eucaine containing adrenalin is injected, whereas with the former alone the analgesia lasts only for fifteen minutes. The analgesia is, however, produced more slowly when the combined drugs are employed.

The contraction of the arterioles produced by adrenalin chloride hinders absorption by the lymphatics, owing to the diminished flow of blood through the part, or, in other words, by lessening the *vis a tergo*.

The credit of making known the advantages obtained by combining the active principle of the suprarenal gland with cocaine and allied drugs must be given to Braun.

Professor Paul Reclus,* however, does not favour the combination of adrenalin chloride with local anæsthetics, although the consensus of opinion among those who largely employ local anæsthesia is distinctly in favour of these mixtures.

* *La Presse Médicale*, January 3, 1906.

Adrenalin chloride is generally used in 1 per mille solu tion (0·1 per cent.), but often one-tenth, or even one fifteenth, of this strength will suffice. It may be advantageously combined with most of the above-mentioned drugs for the purpose of localizing, and so prolonging and intensifying their action; likewise its constricting effect on the arterioles, causing blanching, determines when the tissues are well infiltrated and ready for operation.

Adrenalin chloride should be discarded if it produces, on boiling, more than a faint pink solution; the solution should be nearly colourless. Suprarenal gland preparations oxidize rapidly when exposed to the air.

Braun fixed the subcutaneous dose of adrenalin chloride at 0·5 milligramme—that is, 0·5 c.c.—of adrenalin chloride solution (1 in 1,000). If more than this quantity is injected, a feeling of constriction of the chest is noticed, accompanied within a few minutes by palpitation of the heart and increased pulse-rate. The poisoning, or toxic power, of adrenalin is diminished, like other drugs, with the degree of its dilution.

Large doses of adrenalin injected hypodermically into animals produce glycosuria, diuresis, and inflammatory changes in the liver and kidneys, and larger quantities cause prostration, collapse, and paralysis of the central nervous system, terminating in failure of respiration and œdema of the lungs. Multiple hæmorrhages occur if the blood-pressure has been greatly raised, and atheromatous degeneration of the aorta has been noted in the rabbit apparently from this cause.

In using any of the above drugs, the salt should be dissolved in distilled water according to the strength required, and sodium chloride added to make an isotonic solution (0·92 per cent. sodium chloride). A few drops of adrenalin chloride (0·1 per cent.) are then added, and the solution

brought up to the boiling-point. These solutions should be used at the temperature of the body.

Many of these anæsthetic drugs can be kept in tablet form, and made up as required. Normal saline solution is readily prepared from a tablet of sodium chloride dissolved and boiled in a definite quantity of water.

Lang* gives the following solutions as isotonic with the blood, and containing respectively 0·4 per cent., 0·8 per cent., and 2 per cent. novocaine, with 3 drops of adrenalin (0·1 per cent.) added to each 10 c.c.

Solution.	A.	B.	C.
Novocaine (4 per cent.)	1 c.c.	2 c.c.	5 c.c.
Saline (4 per cent.)	2 c.c.	2 c.c.	2 c.c.
Adrenalin (0·1 per cent.)	3 drops	3 drops	3 drops
Water, to	10 c.c.	10 c.c.	10 c.c.

Novocaine may be procured in the form of tablets or ampoules of a definite strength. In the latter case the drug has previously been sterilized, and is ready for use.

The author prefers making and sterilizing his solutions as required, especially as the ampoules in which the drug is usually presented do not satisfactorily allow the needle of the syringe to reach the contents.

The following formula produces a 0·2 per cent. solution of eucaine, and contains adrenalin chloride (0·002 per cent.) and other ingredients in the quantities formulated by Braun and adopted by Barker, of University College Hospital:

β-eucaine 0·07 gramme = 1 grain.
Sodium chloride 0·27 gramme = 4 grains.
Aqua destillata 30 c.c. = 1 ounce.
Adrenalin chloride (1 in 1,000) = 3 minims.

* *St. Bartholomew's Hospital Journal*, January, 1908.

This solution is prepared as follows:

An ounce of distilled water is poured into a glass beaker. To this are added 1 grain of β-eucaine and 4 grains of sodium chloride The contents are then boiled for a few minutes, after which the beaker is cooled to blood-heat, and 3 drops of adrenalin chloride (0·1 per cent. solution) are added. The solution should not be boiled for more than a few minutes, or it will become too concentrated, and require the addition of distilled water to make up the original volume.

For tooth extraction a more concentrated solution of eucaine than the above may be employed, and this is prepared in a similar way, except that the ingredients, other than the eucaine, are reduced according to the degree of concentration required; thus a drachm of distilled water will give a solution of eucaine of about 1·5 per cent. in strength, and a stronger solution than this would seldom be required. For the preparation of these smaller quantities a graduated test-tube can conveniently replace the glass beaker.

Compressed powders containing β-eucaine and sodium chloride in the above proportions are procurable.

Markham* favours eucaine lactate as a local anæsthetic, and gives clear and concise directions as to its preparation, and the method of filling and rendering sterile the glass ampoules for its reception.

Dr. Maurice Pôhl† gives an analysis of 625 injections of local anæsthetics, and classifies his results. He obtained the best results from alypin, whereas acoine, nirvanin, and anæsthesin gave poor results; the last two drugs he describes as painful and useless. The injection was followed by syncope in two cases, in both of which cocaine was employed.

* *British Dental Journal*, February 15, 1906.

† *British Journal of Dental Science*, February 1, 1910.

Dosage.

Local anæsthetics are generally used in 0·5 to 2 per cent. solutions. The toxicity of a drug depends more on the concentration of its solution than on the quantity used, so that a larger quantity of a drug can be employed if the solution be weak. The idiosyncrasy of a patient to a particular drug must also be taken into consideration in determining the amount to employ, as what may be a safe dose for one person may have harmful effects on others.

Not more than $\frac{1}{4}$ grain of cocaine should be injected at one visit, and for safety the injection should be conducted with the patient in the supine or semi-recumbent position. A few minims of adrenalin chloride (0·1 per cent.) may be added advantageously to any of the above solutions. The solution of adrenalin chloride should be sterilized before or after its addition to the anæsthetic solution; the latter method is more convenient owing to the small quantity of adrenalin used.

Local anæsthetics at first have a stimulating effect on the central nervous system, so that the patient may become talkative and restless. The pulse is increased in frequency and more forcible, and likewise the respiration.

A feeling of faintness associated with pallor, or even nausea and vomiting, are symptoms which may be due to nervousness of the patient, or to the discomfort associated with the injection, and need to be differentiated from somewhat similar symptoms depending upon the toxic or poisonous effect of the drug.

The Advantages of Local Anæsthesia for Extraction Operations.

1. There is *no need for any assistance*, the operator undertaking both the analgesia and the operation.
2. The analgesia lasts for an hour or more, so that the *operator is not hurried*, and the patient is spared a good deal of the after-pain resulting from the operation.
3. Almost, if not entire, *absence of after-effects*.
4. *No preparation of the patient* beforehand is necessary.
5. *The apparatus required is simple*, cheap, and portable.

In general anæsthesia the higher nerve centres are first affected by the drug, and through them the cranial and spinal nerves to the site of operation. Thus the whole system is saturated with a powerful drug to produce unconsciousness of pain during manipulations in some limited area. In local analgesia, *per contra*, the object in view is to produce a painless area of sufficient extent to permit the same manipulations to be undertaken, and to accomplish this without the general flooding of the tissues by a toxic agent.*

The Advantages of General Anæsthesia for Extraction Operations.

General anæsthesia is preferable for *children*, or *adults lacking in self-control*, and for those cases presenting obstacles to the technique of local anæsthesia—*e.g.*, *trismus of the jaws*, *suppuration around the teeth*, or *sinuses on the gum*.

* "The Methods of Local Analgesia," by Captain J. W. H. Houghton, R.A.M.C., in "A System of Operative Surgery," by F. F. Burghard.

It is *more reliable*, although the author believes local analgesia fails chiefly through want of technique being faithfully carried out. General anæsthesia has the advantage that the *patient is unconscious of the operator's manipulations*, as with local analgesia these can be felt, although not giving rise to painful sensations.

The administration of a general *anæsthetic can be immediately checked* at the onset of unfavourable symptoms, whereas a drug injected into the tissues cannot be withdrawn.

There is no evidence in support of the statement that wound healing is delayed or otherwise interfered with by the injection of a local anæsthetic, provided the technique is carefully observed and isotonic and sterile solutions are employed. A reactionary dilation of the arterioles has been stated to follow the use of adrenalin, and to be a cause of the so-called "post-operative" hæmorrhage. Braun has shown that no subsequent dilation of the arterioles takes place, and even if the vessels did become dilated beyond their normal calibre, the thrombi in their lumina would probably be firmly fixed by the time the constricting effect of the adrenalin had passed off. The tortuosity and the branching of the vessels would form a further buffer to the displacement of clots by the circulating blood.

Technique of Infiltration Anæsthesia.

The Syringe.—It is largely owing to improvements in this that have led to a fresh stimulus in local anæsthesia. Formerly a hypodermic syringe was used; this failed on account of the junctions being insufficiently water-tight, and the syringe too weak for infiltrating dense tissue like the gum. The fluid escaped at the junctions, or leaked back through the asbestos piston.

A good syringe should be powerful, and contain a solid, well-fitting piston, preferably the same length as the barrel (Fig. 54). Unfortunately, the piston seldom fits the barrel sufficiently accurately to do away with washers, besides which the constant wear of metal against metal would sooner or later necessitate their employment. The least objectionable form of washer is one of asbestos, wound around the upper part of the piston before this is passed through the screw-nut.

The author has had several syringes made for him with the idea of avoiding washers, but the working of the syringe is never so accurate in their absence.

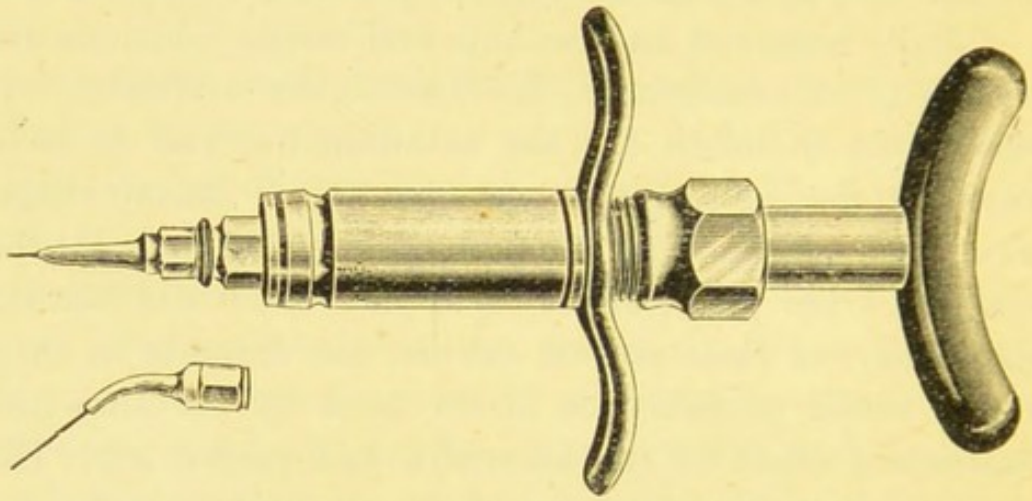

FIG. 54.—IMPERIAL SYRINGE FOR USE IN LOCAL ANALGESIA.

The upper part of the barrel of the syringe should be fitted with a stout cross-piece, to enable the operator to obtain a firm grasp while the piston is propelled into the barrel with the thumb or palm of the hand. The piston-rod should terminate in a broad extremity for the comfort of the hand. All junctions must fit accurately.

The needle should not be over $\frac{1}{4}$ inch in length, and must be sufficiently stout for strength. Its mount should screw on to the syringe, and abut against a firm washer for additional safety. Straight and curved needles are re-

quired, and when not in use should be threaded with a fine wire. The needle and its mount should be in one piece, as this saves a joint, and the shoulder so formed presses against the puncture and prevents leakage. The needle may be made of steel or irido-platinum. Steel needles are finer and sharper than those of irido-platinum, but are more apt to rust, and, being more rigid, are liable to break.

The syringe must be made so that it can be easily taken to pieces, and every portion rendered capable of sterilization.

The metal piston should be graduated in minims, and its barrel capable of containing at least ½ drachm. An additional scale in cubic centimetres is a convenience for solutions that are put up in this measure, and may be superimposed on the smaller minim scale.

The *Imperial Syringe* (Fig. 54) comprises most of the above-mentioned points, and if employed with an asbestos washer in place of the "packings" sold with the instrument, and lubricated with lysol or carbolized vaseline, one of its at present objectionable features is lessened.

A small sterilizer should be kept apart for sterilizing the syringe and its accessories, as traces of alkalies are injurious to the action of these drugs. A metal piston will require some lubricant after removal from the sterilizer, and for this purpose a drop of pure lysol may be smeared over its surface.

Instead of boiling the syringe before use, which, although the safest means of rendering it sterile, is somewhat injurious to its smooth working, the syringe, after being cleansed, may be kept in lysol (10 to 20 per cent.) until again required. Lang recommends a solution containing formaldehyde (formalin, 20 per cent.) and borax (3 per cent.) for this purpose.

The needles should be boiled after being used, threaded with fine wires, and placed in absolute alcohol.

Method of Injection.

Previous to the injection, the mouth may be rinsed with a weak antiseptic, and the site of puncture wiped with a stronger solution of the same antiseptic on cotton-wool.

If the prick be feared, the gum may be touched at the site of puncture with a little pure carbolic acid, or with a solution (saturated) of cocaine applied on a small pellet of

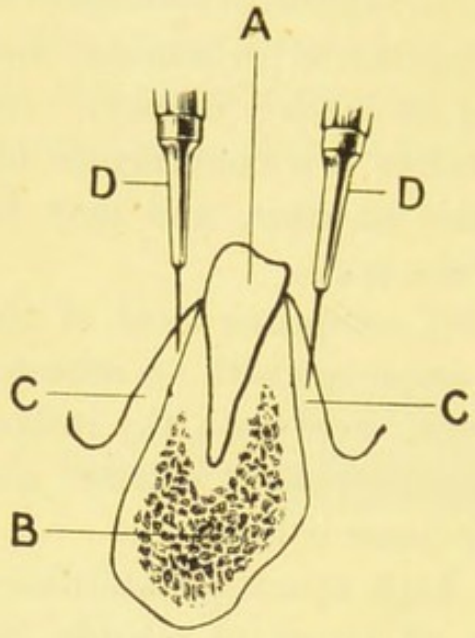

FIG. 55. — VERTICAL SECTION OF MAXILLA (PREMOLAR REGION).

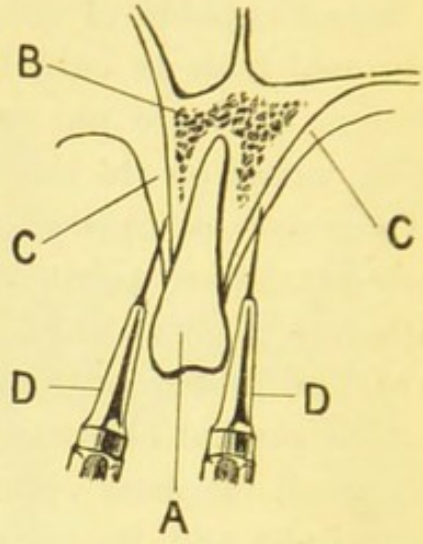

FIG. 56. — VERTICAL SECTION OF MANDIBLE (PREMOLAR REGION).

A, Tooth; *B*, bone of jaw; *C*, mucous membrane; *D*, needle.
(Coleman and Hilliard.)

cotton-wool, either of which will render the gum almost insensitive to the needle.

The needle is inserted obliquely into the gum at a point rather nearer the neck of the tooth than its apex, and to one side of its root, if the amount of soft tissue over the root is scanty. When the eye of the needle is well embedded in the mucous membrane, the solution can be slowly injected, and the needle pushed on towards the apex of the tooth (Figs. 55, 56).

One injection on either side of the gum usually suffices for a single-rooted tooth, whereas for a molar it is sometimes advisable to inject over each root.

The injection should be made slowly and gradually, occupying about a minute over each puncture, and the needle should be retained in position for a few seconds even after the barrel has been discharged, as, until taken up by the circulation, the pressure of fluid in the tissues will be greater than that outside, and leakage may follow the withdrawal of the needle. If but little resistance is encountered, or, on the other hand, the piston cannot be driven on, the needle should be reinserted. The former circumstance may indicate that, the needle has not been inserted sufficiently deep and the fluid has consequently trickled back along the needle, the needle has been pushed into the loose cellular tissue in the sulci of the cheek or floor of the mouth, or leakage of the solution has occurred through an injured socket or sinus. The opposite condition, that of excessive resistance, generally implies that the eye of the needle has become occluded by the alveolus of the jaw.

About 20 minims of a 2 per cent. solution of any of the above-mentioned drugs will suffice to anæsthetize one tooth, and less is required in proportion when anæsthetizing two or three adjacent teeth, as the analgesic zone from one puncture tends to spread to the adjoining teeth.

There should be no further discomfort after a puncture has been made on either side of the tooth, as the operator should utilize the periphery of the analgesic zone for any subsequent puncture that may be required.

A successful injection can be anticipated by the amount of resistance offered, and by the brawny feeling imparted to the tissues. In addition, blanching is well marked when adrenalin has been combined with the solution. The whole

area occupied by the tooth should appear blanched, and be allowed to remain in this condition for four or five minutes before extraction is undertaken. The mucous membrane may be previously tested with the point of the needle to insure that anæsthesia is present.

The injected fluid will sometimes collect in the loose tissue of the sulci of the cheek and floor of the mouth, giving rise to a " boggy " feeling. This is usually an indication that more of the solution has been used than is necessary, or that the needle has been inserted deeper than is required. A healthy and firm mucous membrane will readily blanch, and a good analgesia can be anticipated; whereas, if the tissues be inflamed and œdematous, the vessels having lost their tone do not readily respond to the constricting effect of the adrenalin, and blanching is consequently but little marked. There is said to be some risk in injecting inflamed or suppurating tissues, owing to the organisms or their resulting products being dispersed into the circulation.

Difficulties, Dangers, and Sequelæ of Local Anæsthesia.

Difficulties and Dangers of Local Anæsthesia.

The difficulties, which may also be the cause of dangers, arise chiefly from the position of the tooth and its pathological condition.

For *back teeth* a mouth mirror is frequently necessary for pushing aside the tongue or cheek, and allowing a clearer view of the surroundings of the tooth. There may be difficulty in infiltrating the *lingual aspect of the lower molar region*, especially when the teeth have large crowns and are inwardly tilted. This mechanical difficulty could be largely overcome if the needle-carrier were curved, so as not to impinge on the tooth during its insertion. The

outer aspect of the lower molar region may also offer a difficulty, if the external oblique ridge be prominent, and prevent the needle from satisfactorily following the root of the tooth. In such cases it has been suggested that the freezing process might be employed on the side difficult of access for injection.

Malplaced teeth may give rise to difficulty in their infiltration, as well as in their subsequent extraction.

Difficulties and dangers arising from pathological conditions of the teeth or their surroundings may be due to—

Sinuses in the area of infiltration.
Injured tooth-sockets, as by previous attempts at extraction.
An *alveolar abscess.*
Suppuration around tooth-sockets—*e.g.*, pyorrhœa alveolaris.
Macroglossia.
Microstoma.

And other less common conditions.

Sinuses on the gum or injured tooth-sockets give rise to difficulty in infiltrating around a tooth, owing to the solution escaping through the sinus or tooth-socket, as fast as it is injected.

Organisms, toxins or their products, may be dispersed deeper into the tissues if the injection be made in their proximity, or these organisms might be carried into the circulation, should the needle of the syringe penetrate the lumen of a vessel.

Macroglossia and microstoma offer mechanical difficulties to the technique of local anæsthesia.

Breakage of a Needle.—If a needle breaks in the gum, as a rule it is easily removed; but if this accident occurs while injecting the inner surface of the lower jaw, more

especially if a long, slender needle has been used and deeply inserted, there may be great difficulty in removing the broken piece.

Should the broken piece reach the muscles of the tongue and floor of the mouth, or become embedded in the submaxillary gland, no time should be lost in having the needle localized by radiography and removed. A needle will travel rapidly in muscular or glandular tissue, especially in a situation like the floor of the mouth, which is in constant movement. If treatment be delayed, the point of entrance of the needle will soon cease to be a guide as to its position.

Sequelæ of Local Anæsthesia.

The unfortunate sequelæ of local anæsthesia are chiefly dependent upon the toxicity of the drug and the idiosyncrasy of the patient to that drug.

Anæmic patients and those liable to giddiness and faintness are not good subjects for local anæsthesia, and small doses may give rise to a further depression of their circulatory organs (*syncope*).

Toxic Symptoms have been chiefly recorded in connection with cocaine. Cocaine is liable to produce constitutional symptoms, owing to its depressing action on the circulation through the medulla. Dr. Sauvez, however, makes the following statement, based on an analysis of 15,000 injections: "We cannot register one accident, not even an incident due to the use of cocaine." Dr. Sauvez recommends the horizontal position if the injection exceeds 1 c.c. of a 1 per cent. solution of cocaine (*i.e.*, $\frac{1}{6}$ grain), and advises that the patient should maintain the recumbent posture for at least a quarter of an hour after the operation.

Cocaine-Poisoning.—The pulse is quickened after the injection of cocaine, owing to direct action on the cardiac

muscle, or to depression of the vagus; larger doses, by stimulating the vagus, slow the pulse.

Stimulation of the respiratory centre causes rapid and deep breathing; later, owing to depression of this centre, the respiration becomes feeble, and death may ensue from asphyxia. The pupils become slowly dilated, reaching their maximum mydriasis within an hour or two, and in this condition they may remain for twenty-four hours. The dilated pupil reacts slightly to light and accommodation. The pupil effects are due to irritation of the sympathetic. Besides a feeble pulse, shallow respiration, and widely dilated pupils, there is a feeling of chilliness and restlessness, accompanied by delirium.

Convulsive movements are not uncommon, and are probably due to anæmia of the brain, induced by irritation of the vasomotor centre.

The secretion of saliva is at first increased; later the secretion is diminished, so that dryness of the mouth becomes a clinical sign of cocaine-poisoning.

Malaise and weakness lasting a few minutes or days may follow the use of an excessive dose of cocaine.

Following an unsuitable dose of cocaine, whether from the quantity used, the method of its employment, or the personal susceptibility to the drug, the patient is seized with a feeling of faintness and giddiness, and if unsupported may fall. The pulse becomes quickened, weak or imperceptible at the wrist; the respiration quiet and shallow. A temporary and sudden lapse of consciousness followed by an equally sudden revival is not uncommon, and the patient may experience a succession of such attacks, each attack being preceded by cold sweating. The patient is not infrequently sick on the return of consciousness, and this sign is often a precursor of recovery. Headache and giddiness may persist for the remainder of the day.

If the patient be in the dental chair, his head should be bent forward, or, better still, the back of the chair lowered so that the supine position is assumed. The patient should be kept warm with blankets or rugs, and any tight clothing loosened. Brandy or hot coffee, or an ether draught, should be administered, or, if unconsciousness is present, ether (℥i.) or strychnine ($\frac{1}{50}$ grain) injected hypodermically.

The patient must be watched throughout, and at the first sign of respiratory failure, artificial respiration must be resorted to and maintained for some time after the breathing has resumed, for the respiration is liable again to become weak after all apparent danger has passed. The first measures are most important—*i.e.*, position and warmth—but as the seriousness of the patient's condition cannot always be foretold, no time should be lost in preparing for emergencies.

Toxic symptoms arising from local anæsthetics other than cocaine are somewhat similar to those already mentioned, and require to be treated on the same lines.

Paralysis of the central nervous system is the cause of death in poisoning from local anæsthetics.

Adrenalin-Poisoning.—Symptoms of poisoning arising from the injection of adrenalin chloride may be confused with those due to the associated anæsthetic, and only recently has it been suggested that some of the graver symptoms may be due to the action of this poisonous alkaloid.

The injection of adrenalin has been followed by marked circulatory depression, where it has been employed for diminishing the blood-supply in the operative area—*e.g.*, in submucous resection of the nasal septum. These symptoms are apparently unaccountable by the operation or the general anæsthesia under which it is performed.

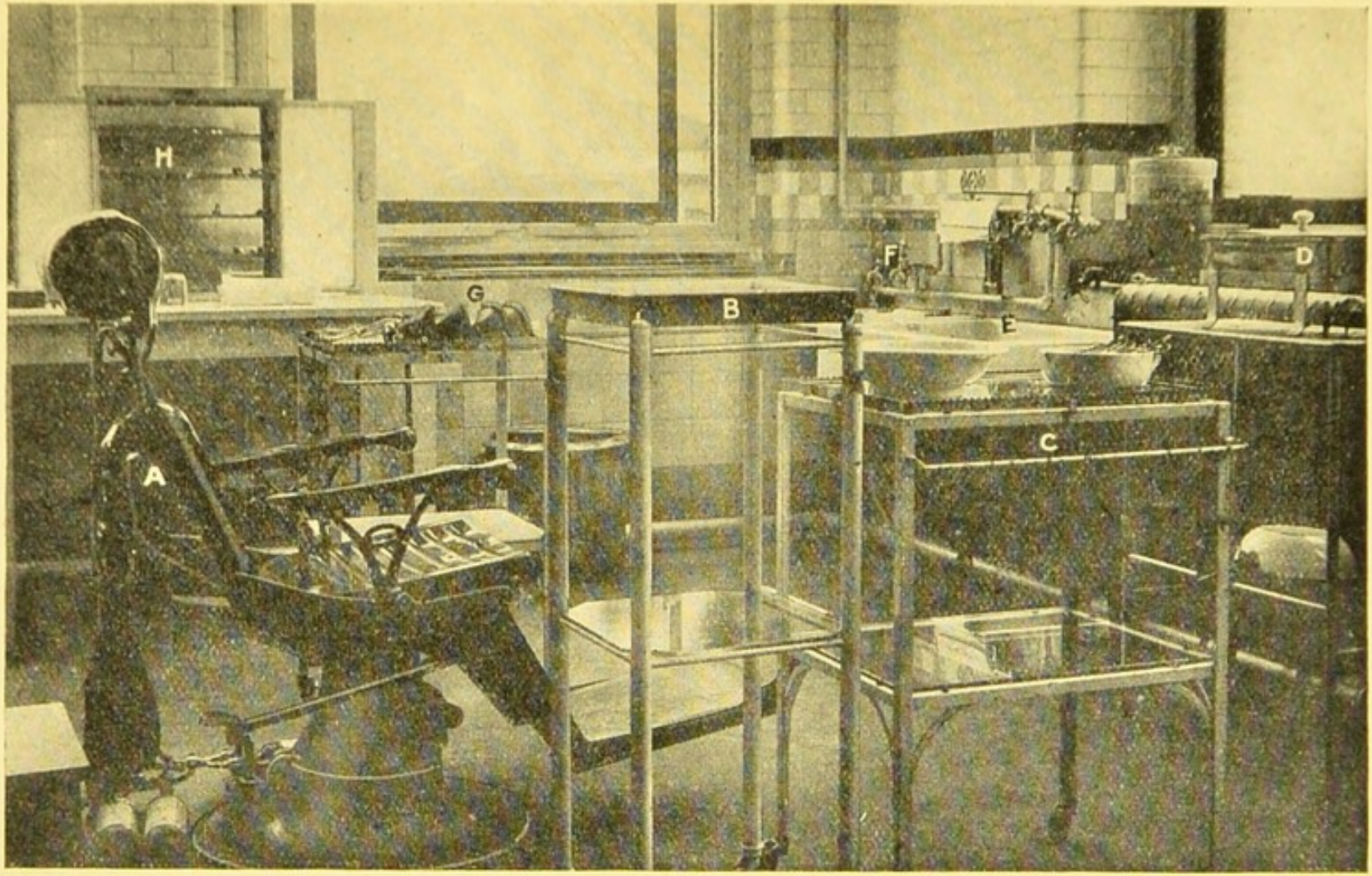

FIG. 57.—SHOWING AN OPERATING-ROOM AND ITS REQUIREMENTS.

A, Dental chair; *B*, tray for instruments; *C*, table for sponges, mouth-props, etc.; *D*, sterilizer; *E*, sink; *F*, wash-basin; *G*, anæsthetist's table; *H*, instrument cabinet.

Dr. Blumfeld* records the symptoms of sudden pallor, feeble breathing, dilated pupils, and insensitive corneæ in a patient in whom 6 drops of adrenalin chloride solution (0·025 per cent.) were injected into the mucous membrane of the nasal septum, as a preliminary to its resection. The anæsthetic employed was a chloroform and ether mixture, which was temporarily suspended during the adrenalin injection. Chest compression together with lowering of the head and shoulders restored the patient.

Mr. A. D. Fleming† has noted faintness after the injection of adrenalin chloride in strengths similar to that employed in Dr. Blumfeld's case, but never in solutions of 1 in 50,000 or less. He records a fatality after an intramuscular injection of a minim of a 0·1 per cent. solution of adrenalin, but in the case cited there is doubt as to whether the operation may not have been the primary cause of death.

Dr. Goodman Levy‡ has drawn attention to the effect of adrenalin on the heart in chloroformed subjects.

The depressing effects of adrenalin appear to be exaggerated in the narcotized patient, and most of the fatalities have occurred during general anæsthesia.

* Proceedings of the Royal Society of Medicine, February, 1911.

† *Ibid.*

‡ *British Medical Journal*, September 14, 1912.

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THE END

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Wheelchairs

① Mechanical

② Pathological