The surgical treatment of neuralgia of the fifth nerve (tic-douloureux).

SURGICAL TREATMENT

OF

NEURALGIA

ROSE

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OF THE FIFTH NERVE.

(TIC-DOULOUREUX.)

BY

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PREFACE.

I HAVE ventured to publish these three lectures on the Surgical Treatment of Neuralgia of the Fifth Nerve which I delivered as Lettsomian Lecturer for 1892 before the Medical Society of London, in the hope that they being, I trust, a fair *résumé* of what has been accomplished hitherto in this direction, may prove of some assistance to others pursuing the same course. I have much pleasure in acknowledging my indebtedness to my colleague, Mr. Carless, for his valuable assistance in the preparation of the lectures, particularly in collating the foreign literature and in seeing them through the Press. I have also to acknowledge the courtesy of Sir William MacCormac, and Messrs. Longmans & Co. in lending me some anatomical blocks.

17 HARLEY STREET,

July, 1892.

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SURGICAL TREATMENT

OF

NEURALGIA OF THE FIFTH NERVE

(TIC DOULOUREUX).

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MR. PRESIDENT AND GENTLEMEN—

On occasions like the present it is the pleasurable duty of the Lettsomian Lecturer to commence by thanking you and the Fellows of the Society for the honour conferred upon him, and although my acknowledgment be brief, I am in no way behind my illustrious predecessors in my appreciation of this distinction.

The difficulty of selecting a subject which shall touch on new ground increases as years roll by, and in considering what I could best bring before your notice it seemed to me that an account of my recent experiences in the treatment of intractable trigeminal neuralgia would be interesting to the profession generally, and acceptable to you. And the more do I feel this, since on glancing over the list of subjects dealt with by the distinguished men who have preceded me in this position I observe that with the exception of the year 1866, when

the late Dr. Anstie delivered a course of lectures on "Some Painful Affections of the 5th Nerve," this subject has not been touched upon.

The fact that up to the present time this disease has baffled all the attempts of medical and surgical treatment mark it out as one that demands further attention and the free-est discussion both from the pathological and clinical standpoints. Details as to the morbid anatomy of this disease are extremely scanty; indeed it has by no means received the attention from pathologists that it deserves, although recently two or three important papers have appeared in the American journals dealing with the pathological conditions of the nerves and blood vessels, to which I shall allude later. In future, wherever practicable, the portions of resected nerves should be examined microscopically, and every opportunity taken of learning more of the local conditions which may be present; all cases operated on should be kept under observation, if possible, for years, so that reliable statistics may ultimately be obtained. The great majority of recorded cases are diminished in value from the fact that this precaution has not been adopted. The plan I propose to follow in these lectures is to give a review of the various surgical methods adopted in the treatment of this disease after a short introduction, devoted to its causation, pathology, and symptoms, inasmuch as an accurate estimate of these must be formed as a basis of scientific treatment; and I believe I shall be able to demonstrate, both by the experience of others and my own, that surgical treatment of the trunks of the 5th nerve in the severest forms of this affection has not been attended with anything like average success, and to submit a more radical means of dealing with this complaint in the extirpation of the Gasserian ganglion, providing that this can be accomplished without risk to life, and with, let us hope, every prospect of permanent relief.

The frequency of this particular form of trigeminal neuralgia is such as to constantly obtrude itself before the general practitioner, and its distressing character warrants even the most severe measures being taken for its

treatment. From the statistics of the Bonn clinic given by Conrads in 1889, it is observed that out of 717 cases of neuralgia under treatment, 239 were of the 5th nerve, a number only slightly exceeded in the sciatic, in which 243 cases were met with, whilst only 112 instances of intercostal neuralgia were present, and 54 of cervico-brachial.

With regard to the causes of this disease, I would suggest the following as a convenient *ætiological classification* :—

I. Intracranial—cerebral;
radical;
ganglionic.
II. Cranial.
III. Extracranial or peripheral.
IV. Toxic, *e.g.*, mercury, lead, or malaria.
V. Reflex.
VI. Functional.

Amongst the *cerebral* causes may be mentioned sclerosis, and aneurisms or tumours interfering with the deep origins of the nerve in the pons and medulla. Probably some of the toxic bodies may act upon the centres and thus produce neuralgic pain, whilst syphilis is a potent factor in its production, if we may argue from analogous conditions of the nerve centres elsewhere.

Dr. Putnam (*a*), in an able paper, has recently advanced some important points for consideration in reference to the central causation of neuralgia, and the effect of central disturbances upon the peripheral nerve trunks, along which the morbid nervous stimuli pass. He suggests that the following predisposing factors of trigeminal neuralgia exist, viz.:—

(i.) The large extent of the deep origins, and hence the existence of wide connections with other nerve tracks rendering this nerve more liable to be affected at its origin by morbid influences from many extraneous sources independent of its own area of distribution; and

(*a*) *Boston Medical and Surgical Journal*, August 13 and 20, 1891.

(ii.) The elaborate and delicate organisation of the centres as evidenced by the exquisite sensibility of the parts supplied by it, *e.g.*, the lips, tongue, and eyes.

He also maintains that a peripheral neuritis may be the sequence of severe and frequent nerve-storms passing along a particular nerve-track, emanating from a diseased centre, basing his argument on the fact that even physiological action produces demonstrable changes in the shape and size of a cell-nucleus.

Radical causes. The sensory root of the 5th nerve between the exit from the Pons and the Gasserian ganglion may also possibly be affected. The dural sheath and the aperture in the dura mater through which the nerve passes may from inflammatory thickening become an important item in originating the trouble. In one of my cases of removal of the Gasserian ganglion this opening in the dura mater was seen, and it certainly appeared small in comparison with the size of the nerve passing through it.

Ganglionic causes. The Gasserian ganglion itself may be the seat of chronic inflammatory or interstitial disease, leading

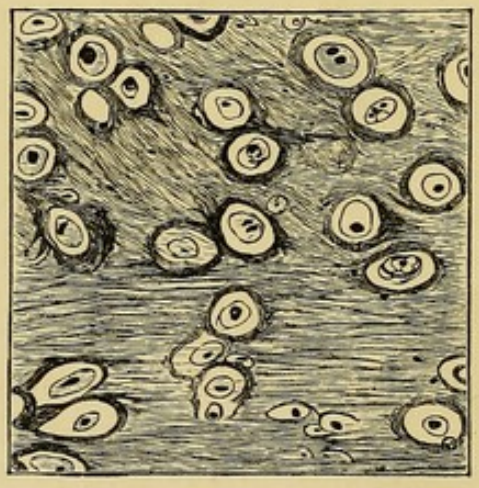

FIG. 1.—Section of a portion of the Gasserian ganglion in Case I, showing thickened and sclerosed connective tissue, and irregular shape of ganglion cells. Seen under 1-5th inch objective.

to sclerosis and subsequent pressure on the nerve cells. The first case in which I removed the ganglion, an account of which is given in the Medical Society's Transactions (Vol. XIV), with a woodcut of the miscroscopic section, is presumably an instance of this (Fig. 1). It is interesting to compare the statement of Carnochan as to the importance he assigned to Meckel's ganglion in infraorbital neuralgia. He says :—" I believe that in such aggravated cases of neuralgia the key of the operation is in *the removal of Meckel's ganglion or its isolation from the Encephalon.* Where even a large portion of the second branch of the fifth pair has been simply exsected from the infraorbital canal, the ganglion of Meckel continues to provide to a great extent the nervous ramifications which will still maintain and keep up the diversified neuralgic pains. Besides, the ganglion of Meckel being composed of *gray matter, must play an important part as a generator of nervous power,* of which, like a galvanic battery, it affords a continual supply ; while the branches of the ganglion, under the influence of the diseased trunk, serve as conductors of the accumulated morbid nervous sensibility." (*a*)

As to the *Cranial* causes, the fact that all the branches of this nerve have to pass through bony canals on their way to their peripheral distribution is another element which must not be lost sight of in considering the causation of this disease. In the first place, in fractures of the base of the skull, implicating any of the foramina, subsequent formations of new bone in the process of repair may press injuriously upon one or other of the trunks ; and we can also imagine that a syphilitic periostitis may diminish their lumen with a similar result. Bony or malignant tumours connected with the base of the skull, and extravasations of blood, from meningeal hæmorrhage for example, might induce pressure, either immediately or subsequently from cicatricial development. Mr. Carless has made a number of careful observations on a series of skulls in the museums of King's College and the Royal College of Surgeons, as to the size

(*a*) *American Journal of Medical Science*, 1858, p. 136.

and relative position of the foramen ovale, and the results he arrives at are very interesting. The shape and size of the foramen ovale, he states, are not constant, and differ in every conceivable way. Thus not only does the form vary from almost a circle to that of a long narrow slit, but the absolute calibre is by no means constant, and the foramina on the two sides of the skull by no means symmetrical. As a rule, however, the foramen is rightly named "oval," the long diameter being inclined backward and outward. The length varied from

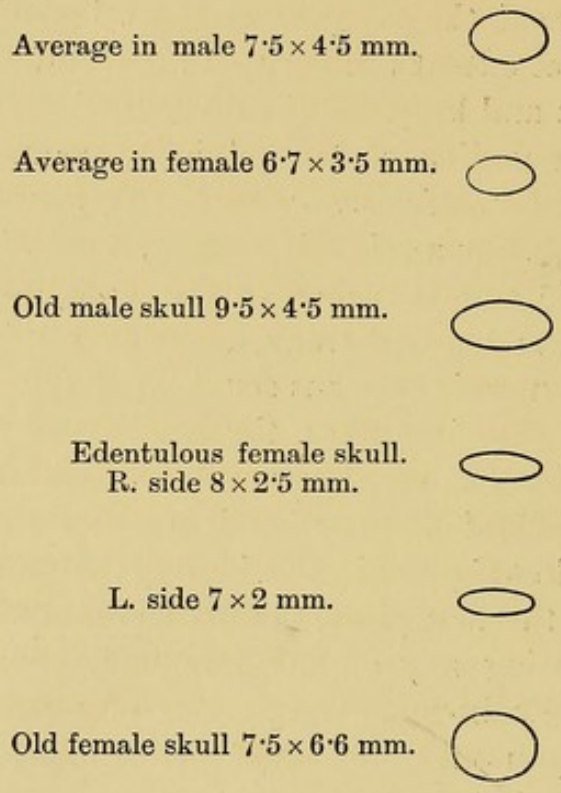

FIG. 2.—Varieties in shape and size of foramen ovale (*actual size*).

6·5 to 9·5 mm. in six male skulls measured, the average being about 7·6 mm.; whilst in twelve female skulls examined the variations were from 5 to 8 mm., the average being 7 mm. on the right side, and 6·5 on the left, *i.e.*, the long diameters of the foramina were distinctly less in female skulls. In breadth, the foramina in the male skulls varied from 3 to 6·5 mm., averaging 4·7 mm. on the right side

and 4·2 mm. on the left. In the female skulls the breadth varied from 2 to 5·5 mm., the mean being 3·4 mm. on the right side and 3·7 mm. on the left, an interesting point to note in connection with the fact that all the patients from whom I have removed the Gasserian ganglion have been females, and the disease has existed in all on the right side.

The varieties of shape which the foramen assumes can be gauged by the following measurements of some extreme cases :—In one old massive male skull the foramina on each side measured 9·5 × 4·5 mm., whilst in an edentulous female skull the measurements were 8 × 2·5 mm., and 7 × 2 mm., on the right and left sides respectively; and still in another, 7·5 × 6·6 mm., the foramen being nearly circular. The average size of the foramen in a male is about 7·5 × 4·5 mm., and in a female 6·7 × 3·5 mm. In one skull examined the foramen was very large and quite heart-shaped. The disproportion often existing between the foramina on the two sides of the skull will be evidenced by the fact that of the 18 measured in only one case did they actually correspond, although in 3 others the measurements were nearly alike (Fig. 2).

The size of the foramina does not seem to change at all regularly with the age, for whilst some edentulous skulls have large foramina, others have small; and young skulls show similar variations. The largest foramina occur in heavy thickened skulls, and the shape and size of the cranium seem to influence that of the foramen much more than does either the age or the sex. Perhaps it may be correct to say that *relatively* the foramina are larger in younger skulls, and in those of the male sex.

Under *Extracranial* or *Peripheral* causes we include any definite peripheral lesion affecting the nerve trunks from their point of exit from the skull to their ultimate fibrillæ. Implication of the nerve in cicatrices, impaction of foreign bodies, pressure from tumours, all find their place here, as well as many other conditions; but special attention must be devoted to two or three of these, *e.g.* :—

1. Those connected with the Teeth.

It goes without saying that dental caries is a fertile

cause of neuralgia, and that often of a most intense character. Neucourt and Friedberg have rightly emphasised it, noting the fact that the tooth which is the real cause of the trouble is not necessarily painful. They also declare that the pain may sometimes be cured by extracting a non-painful carious tooth, whilst on the other hand it may occasionally be increased by extracting a painful one. In some cases it may appear to start from a sound and painless tooth upon the same side.

Gross states that facial neuralgia may be caused by the alveoli of edentulous jaws becoming filled with bone, and so compressing the nerve filaments; he has relieved the pain in these cases by either removing small wedges of bone or by drilling into the affected area.

2. The condition of the peripheral bony canals through which the nerves pass, *e.g.*, the infra-orbital and inferior dental, is another most important matter for consideration. The space within is very small, and any periosteal swelling or deposit of new bone would diminish the lumen, and thus compress the nerve. In more than one instance I have found this condition in the inferior dental canal; unfortunately when once neuritis has been started by pressure in this way, it often has a tendency to spread. Thus in the first case in which I removed the ganglion, the original cause was evidently, as shown by a former operation, pressure upon the dental nerve by a new formation of bone. This was temporarily relieved by the earlier operation of trephining the jaw, but recurred, needing more severe measures. It is a significant fact that in children, when relatively the bony canals are widest, severe neuralgia is practically unknown.

3. Exposure to damp or cold may be legitimately looked upon as an exciting cause of peripheral neuralgia by setting up a rheumatic perineuritis, causing exudation into the nerve sheath and pressure upon the nervi nervorum leading to permanent organic change.

Retention of secretion in the frontal sinuses has been known to cause neuralgia (Horner and Seelig Müller); as also diseases of the ear (Tröltsch and Moss).

The last three divisions in our ætiological table, *viz.*,

the *toxic*, *reflex*, and *functional* groups, will receive but slight notice here. At the same time I cannot help being impressed with the fact that in a large majority of neuralgic patients there is a distinct neurotic temperament, inherited from the parents or acquired, which undoubtedly forms an element amongst the predisposing causes of this disease. Indeed Dr. Buzzard (*a*) goes so far as to say that in many cases of epileptiform neuralgia, especially of the third division, there is a hereditary tendency to insanity. A marked condition of anæmia is constantly exhibited by many of these patients, and was emphasised by my illustrious predecessor, Dr. Anstie, in his famous dictum "Neuralgia is the Prayer of the Nerve for Blood." But although these functional defects play an important *rôle* in the determination of the neuralgic state, they still can be alleviated, and should not be allowed to continue, otherwise as has been already pointed out, the functional trouble may merge into an organic lesion of a permanent and progressive character, which can only be relieved by very serious operative measures. Mental anxiety and worry are often looked upon as being closely connected with the production of neuralgia, but we are in ignorance as to the manner in which this is brought about.

A marked distinction should be drawn between those cases, on the one hand, of simple neuralgia dependent on slight functional derangement, which can generally be cured by medicinal treatment, and those severe and intractable forms known as Tic douloureux, or Fothergillian neuralgia, which was also christened "Tic epileptiforme," by Trousseau, and to which more recently the name "Epileptiform Neuralgia" has been applied. This latter name is perhaps a more suitable one than would at first appear; for although the motor nerves are but slightly and secondarily affected, yet the explosions of nerve force, or convulsions of pain, along the sensory nerve tracks bear a certain resemblance to the typical motor phenomena ordinarily associated with the term Epilepsy.

This severe variety is more common in the

(*a*) Quain's Dictionary of Medicine—See article on "*Tic.*"

2nd and 3rd divisions of the nerve than in the 1st, the infra-orbital and inferior dental branches being especially liable to it. The simple form would appear to more commonly affect the ophthalmic division, and it is now generally acknowledged that supra-orbital neuralgia is more closely associated with central neurosal conditions, such as Migraine, etc., rather than with Tic. The amenability of this form to quinine, and the frequent periodicity of the attacks has suggested the term "Brow-ague," so often applied to it, although there is no absolute evidence connecting it with malarial poisoning.

An interesting paper was contributed at the beginning of last year by Prof. C. L. Dana (*a*) to the American Society of Neurology dealing with the pathology of this disease, and based on the microscopic examination of the excised nerves in several cases. He admits that many inveterate trigeminal neuralgias are due to local lesions, such as exostoses, aneurisms, syphilitic growths, &c.; but maintains that the cases of bad tic commonly seen commencing in the superior maxillary branch or in the inferior dental after middle life are of an entirely different nature. He does not think that the pain is due to neuritis or nerve degeneration, because as a rule there is no permanent anæsthesia; whilst in cases of progressive trigeminal anæsthesia from a degenerative neuritis, there is as a rule but little pain. The former of these propositions can hardly hold good, inasmuch as even when the nerve has been removed, very slight anæsthesia remains permanently, other communicating nerves apparently taking on the duties of the one removed. In most of the nerves examined by Professor Dana no degenerative changes could be found in any of the nervous tissue proper, but very marked and noteworthy pathological conditions were observed in the arteries accompanying the nerves; and he considers that many such cases are due to an obliterating endarteritis of the nutrient vessels of the nerves. (Fig. 3.) The reasons he adduces for this opinion are the following:—

1. The disease occurs at that period of life when arterial changes begin.

(*a*) *Journal of Nervous and Mental Disease*, No. 1, 1891.

2. It affects chiefly and primarily a nerve supplied by one of the branches of the internal maxillary artery, *i.e.*, either the infra-orbital or inferior dental. As has been

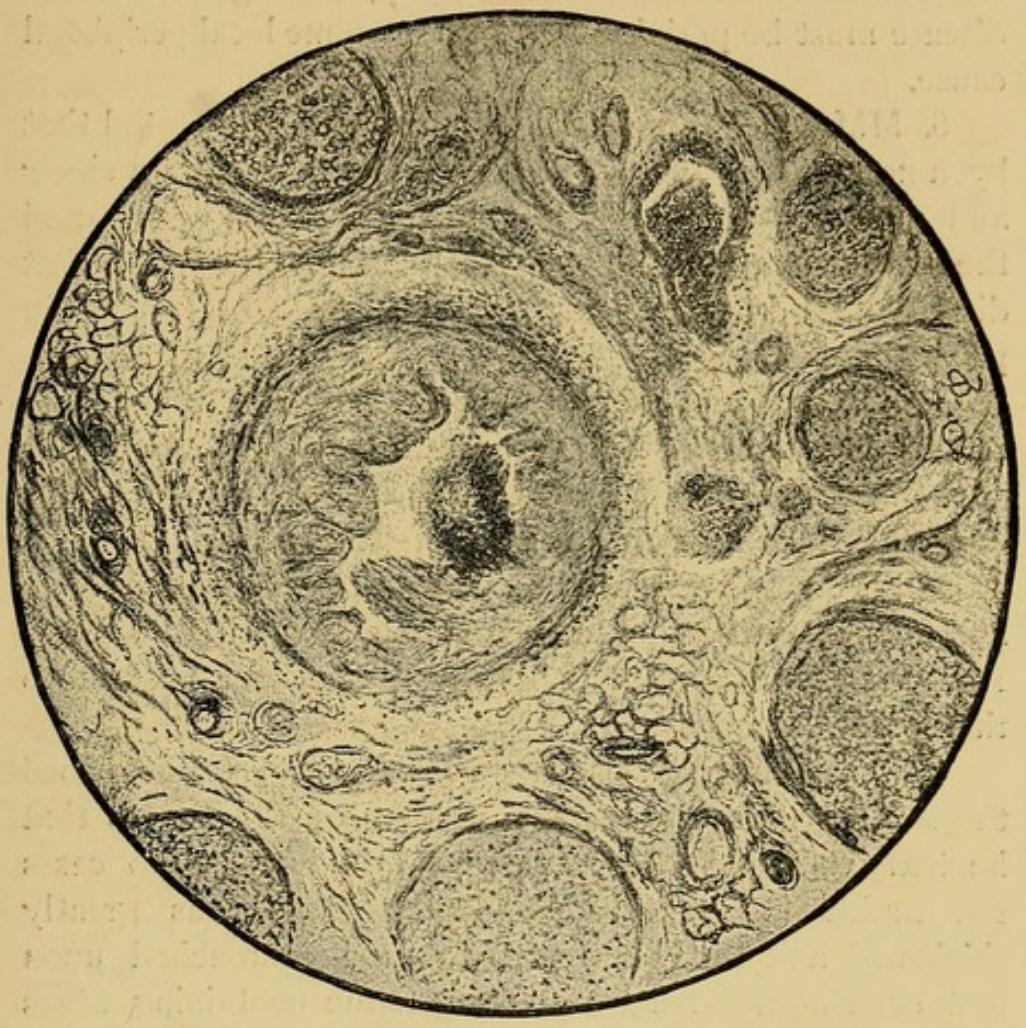

FIG. 3.—Section of arteriole in a condition of obliterative endarteritis from nerve excised for epileptiform neuralgia. (After *Dana*.)

already pointed out, the supra-orbital nerve is but rarely the seat of epileptiform neuralgia, and it is a noteworthy fact that it is supplied by a branch from an entirely different arterial system, viz., the internal carotid. Hence the disease follows a certain fixed vascular distribution.

3. Microscopic examination of excised nerves demonstrated a striking arterial degeneration in three out of five specimens examined; in the other two nerves no arterial twig was visible in the sections.

4. Therapeutic experience strengthens this view in that nitro-glycerine will occasionally give relief quickly, the

effect lasting for some time. Aconite, too, by diminishing the pulse tension, is used with advantage.

5. As there is no doubt that removal of the peripheral nerves sometimes cures tic entirely, he argues that the disease must be peripheral and due to some local peripheral cause.

6. MM. Quenan and Lepars have recently stated that by a new means of injection they have discovered a closer and more extensive relationship between the vessels and the nerves than was hitherto suspected, and suggest that disturbances in blood supply may be an element in producing neuralgia.

Professor Dana admits that there are weak points in this theory, and only claims that the arterial change is one of the factors in the production of the severe cases of tic, whilst a special vulnerability of the central nervous system is another essential predisposing condition. Time and further observation will alone decide whether Professor Dana's theory is correct in giving a causative position to this arterial change.

Independently of this paper, Dr. Putnam (*a*) described the same process as evident in some of the nerves that he had examined. He states that in one or two cases the tunica intima of the blood vessels was greatly thickened and the lumen of the vessel encroached upon and even obliterated by a dense tissue containing fibres and nuclei. In one or more large vessels affected in this way, the central mass of tissue appeared to be attached to one portion of the vessel wall, and opposite this the fenestrated membrane, which everywhere else was perfectly distinct, had entirely disappeared. (Fig. 4.)

I cannot add much from personal observation to this interesting idea, but certainly in several of my cases I have been much struck with the size of the vessels and the substantial thickness of their walls; and this was particularly the case in the inferior dental artery of a patient on whom I recently operated; moreover in one of

(*a*) Putnam. *Boston Medical and Surgical Journal*, Aug. 20th, 1891.

the microscopic specimens made for me by Mr. Turner of the tissue removed in the third case in which I endeavoured to extirpate the Gasserian ganglion, this condition appears

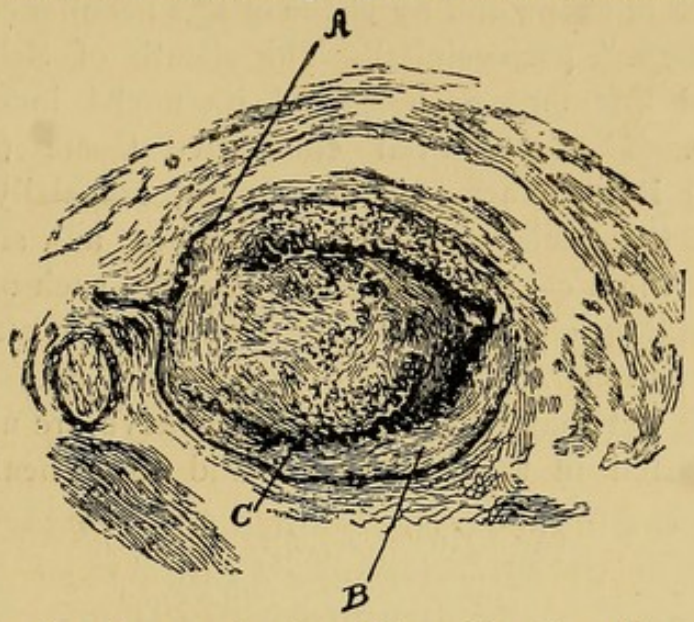

FIG. 4.—Section of nerve showing obliteration of small arteriole in a case of epileptiform tic by a mass of fibro-cicatricial tissue growing in from the wall at a spot where Henle's elastic membrane is absent.

(*a*) Tunica adventitia.
(*b*) Tunica media.
(*c*) Tunica intima and Henle's membrane.

(After *Putnam*).

to be present in what is probably a portion of the small meningeal artery.

The majority of observers do not agree with the statement of Professor Dana that there are no definite changes in the nervous elements. Horsley, (*a*) Schweinitz, (*b*) and Putnam (*c*) all speak very definitely of microscopical appearances of a sclerosing nature, and this I can fully confirm. The axis cylinders are found swollen, or shrunken, and sometimes have disappeared entirely; they are usually difficult to stain with either logwood or carmine. The medullary substance often appears swollen, and the sections of the tubules are not clear and sharply defined, but

(*a*) Horsley. "Transactions Odontological Society," 1887, xix, p. 270.

(*b*) Schweinitz, *v.* paper by Ewing Mears, "Transactions American Surgical Association," 1884, ii, p. 469.

(*c*) Putnam *op. cit.*

consist of a confused mass of concentric rings. "The transverse section of nerve fibres might in places be not incorrectly compared to the interior aspect of a minute oyster-shell both in shape and by virtue of this peculiar concentric arrangement" (Schweinitz). The sheath of Schwann is crumpled up more or less, and its nuclei increased in numbers. The interstitial connective tissue (or endoneurium) is also increased in amount, especially around the blood vessels. These appearances are similar to those seen in a case of chronic neuritis, and such must be of an ascending character, as the changes are often more marked peripherally than at the central end. Putnam notes the fact that all the fibres in a nerve are not invariably affected in the same way, and often healthy and

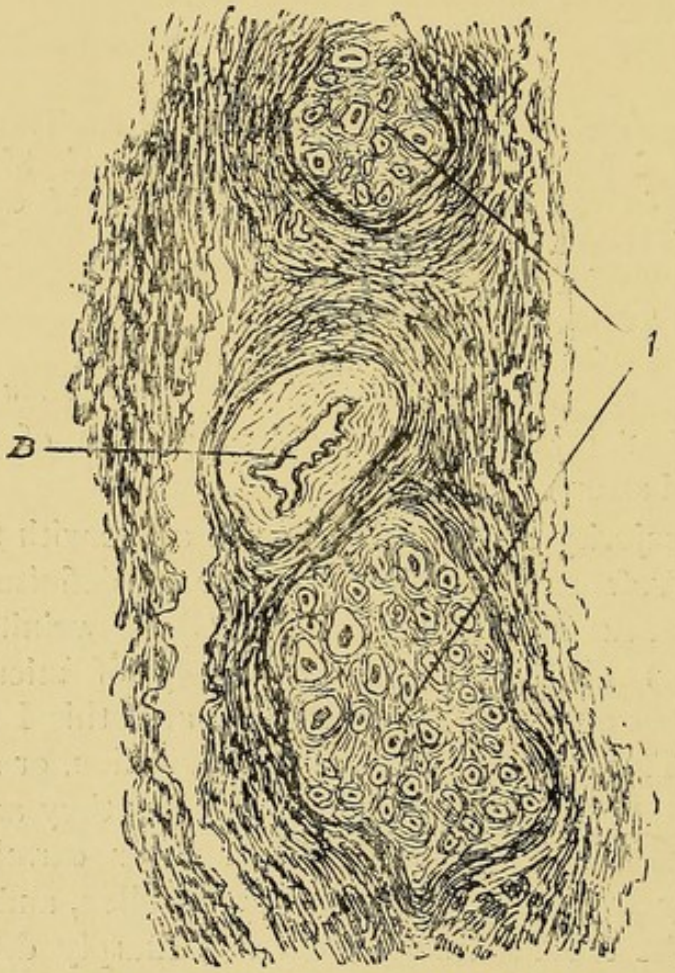

FIG. 5.—Section of nerve in a case of epileptiform tic, showing the irregular condition of the nerve fibrillæ, and particularly of the sheath of Schwann (A); there is some increase of the connective tissue. An arteriole (B) with thickened wall is also seen. (After *Putnam.*)

diseased tubules may be seen in the same section lying side by side. The perineurium is also in some cases thickened, and some observers have noticed small nerve bundles lying in this tissue with the fibres very much changed. These are probably the remains of the "nervi nervorum" described by the late Mr. John Marshall, the compression of which may possibly be one of the chief factors in the production of the pain. (Fig. 5.)

Leaving the pathological question, we will now turn to the clinical aspect to discuss the leading symptoms which are usually met with in a typical case.

The patient, usually a female, and probably in the middle period of life, complains of more or less periodic attacks of severe unilateral cumulative pain, darting along special nerve-tracks, and referred particularly to the points of exit of the peripheral branches upon the face, and especially to those of the 2nd and 3rd divisions. The attacks after reaching a certain pitch of severity suddenly subside, leaving the patient intervals of freedom which, as the complaint advances, become proportionately diminished. As these intervals become shortened, so does the general tone of the nervous system become sympathetically lowered from anxious apprehension and dread of the return of the pain. As a severe paroxysm of pain frequently follows any touching of the affected parts, patients guard them most jealously; washing even is avoided; and I have seen many such cases where the side of the face was distinctly dirty from this cause. Similarly the tongue may become thickly covered with fur on the affected side in consequence partly of the patient using only the opposite side of the mouth in mastication, and possibly also to trophic disturbance.

When once the hyper-excitability of the nerve-centres has been established, so that stimuli from without cannot be retained, but, as it were, overflow tumultuously into definite painful tracks, it matters not where the stimuli come from, the same result always obtains. Thus the patient gets into a morbid state of dread, since any unexpected event, such as the mere slamming of a door, a sudden noise,

or a draught of air is sufficient to precipitate an attack. In the midst of speaking, laughing, coughing, and particularly chewing, a paroxysm occurs with lightning-like rapidity, causing a sudden cessation of any of these acts. The paroxysm dominates the unfortunate patients completely for a time; they frequently hold their hands to the face evincing unmistakable signs of intense suffering. Cases are on record, however, where a sudden cure has resulted from the reception of some unexpected or startling shock, whether physical or psychical, *e.g.*, Sir Henry Lawrence's well-known case, in which he was cured, at least for a time, of neuralgia by the receipt of the news of the Indian Mutiny calling him to instant action.

The special character of the pain must be carefully noted, being entirely different to those migratory or wandering pains which often attack these patients in the intervals between the paroxysms of true Tic, and which might mislead the medical attendant in arriving at a decision as to the exact seat of the lesion. Those who have long suffered from this disease look upon them as trifling in comparison with the agony of which they are so frequently the precursors.

But in addition to the preceding symptoms a typically severe paroxysm includes other phenomena or complications referable to the motor, vasomotor, and secretory apparatus together with disturbances of the special senses.

The effect upon the facial muscles through the intimate connections which exist between the terminal filaments of the 5th and 7th nerves is to induce, firstly, spasmodic contraction as evinced by contortions of the face, and later on paralytic symptoms. The muscles of the eyeball may become similarly affected, and ptosis and external strabismus have been observed from paralysis of the Motor Oculi nerve. During a convulsive seizure the muscles of the jaw supplied by the motor fibres of the trigeminal, as also those supplied by the facial, often become the seat of clonic spasm, which may also extend to those rotating the head.

The vasomotor disturbances most commonly met

with are unilateral hyperæmia of the affected side, suffusion of the conjunctiva, and in cases of longstanding disease tumefaction from venous congestion and consequent inflammatory hyperplasia in the lips, cheeks, sides of the tongue, and floor of the mouth. Partly due to this vasomotor disturbance, and partly to irritation of the excito-secretory fibres is the unilateral sweating of the forehead and side of the face so frequently observed. From a similar cause excessive lachrymation occurs during an attack combined with an abundant flow of nasal mucus and of saliva.

The temporary and permanent effects upon the special senses demand a passing notice. Impairment of vision is present in a small percentage of cases and is probably due to a trophic disturbance in the retina itself, but when temporary may also arise from a transient paresis of the ocular muscles. The sense of hearing is but rarely affected, whilst taste and smell are only in exceptional circumstances interfered with. Even in severe neuralgia of the lingual nerve with intense hyperæsthesia of the affected side of the tongue, the sense of taste may be quite normal.

Another manifestation of this disease, which was formerly looked upon as one of considerable diagnostic importance is that of localised areas of hyperæsthesia, the so-called *Points Douloureux* of Valleix. They are usually located at the points of exit of the terminal branches of the nerves (Fig. 6), but occasionally secondary foci are found in other situations. Thus with neuralgia of the *ophthalmic* division, there is often a tender spot on the scalp a little above the parietal eminence, rendering brushing the hair painful and even impossible. The more common sites of hyperæsthesia are the supra-orbital notch, the upper eyelid, the eyeball, and the junction of the nasal bones and cartilage. As I have previously stated, the neuralgic affections of this division are not so severe, and seldom assume the true characters of the epileptiform variety. In the *second* division these *points douloureux* are found at the infraorbital foramen, over the malar eminence where the temporo-malar branch emerges from the bone, at some spot along the gum of the upper jaw, and even

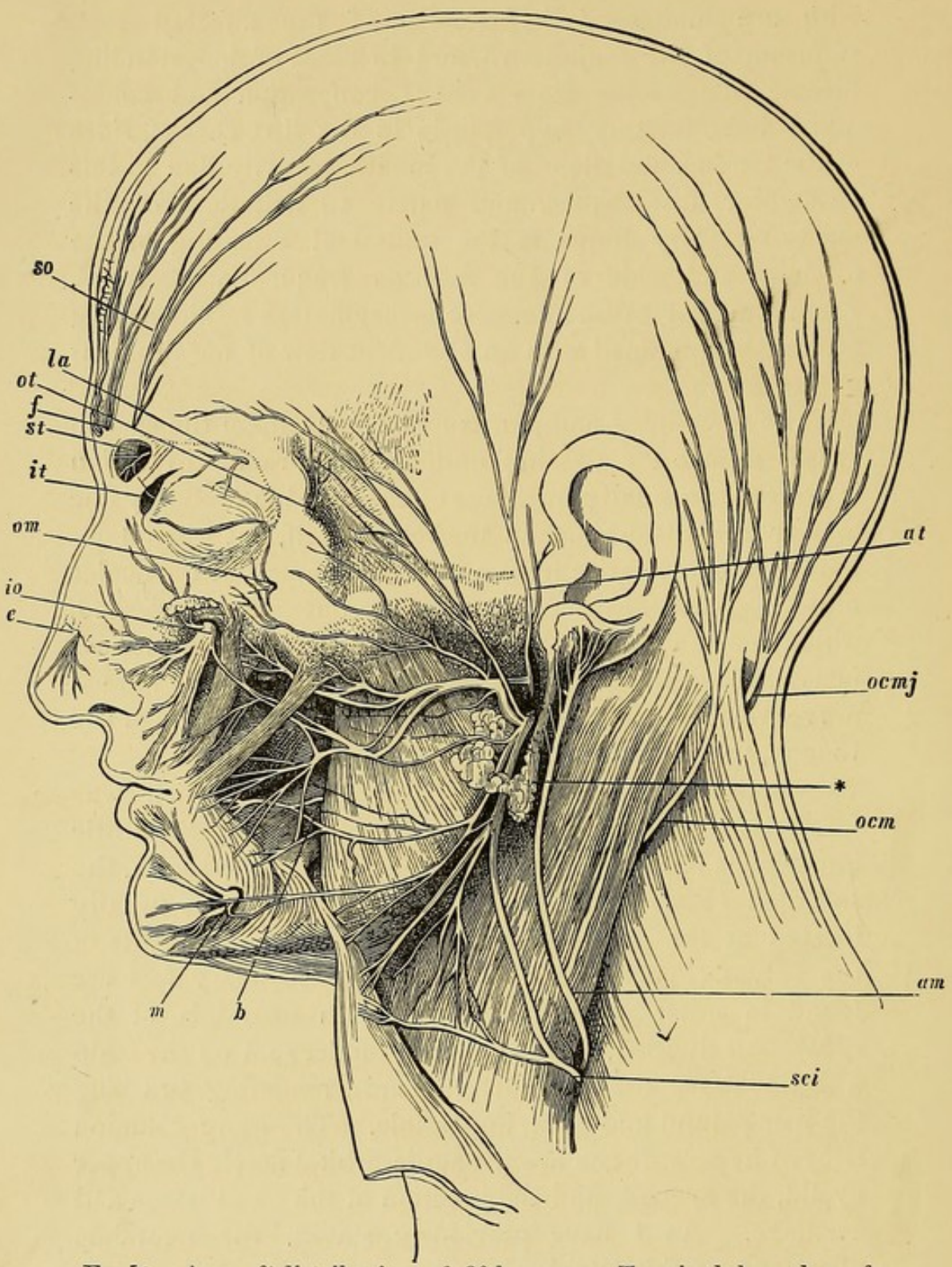

FIG. 6.—Area of distribution of fifth nerve. Terminal branches of the facial and sensory nerves of the face; the parotid gland* is almost completely removed. (*MacCormac.*)

so. Supra-orbital.
la. Lachrymal.
ot. Temporal.
f. Frontal.
st. Supra-trochlear.
it. Infra-trochlear.
om. Malar.
io. Infra-orbital.
c. Nasal branch of ophthalmic.
m. Mental.
b. Buccal.
sci. Superficial cervical.
am. Great auricular.
ocm. Small occipital.
ocmj. Great occipital.
at. Auriculo-temporal.

in the palate at the orifice of the posterior palatine canal. As to the *third* division, the most common situations of these tender spots are at the mental foramen, the side or tip of the tongue, the lower lip, and between the angle of the jaw and the ear. It is more than doubtful whether we can place any diagnostic value upon these tender spots, inasmuch as they are not usually manifest in the earlier stages of the disease; and when at all pronounced they probably indicate a localised organic change of the tissues in the immediate neighbourhood.

The trophic influence of the nerve over the parts supplied by it is shown in the nutritive changes met with in some instances. The skin tends to become thin, shiny and atrophic, similar to the condition known as the "glossy skin," described by Sir James Paget many years ago. This may be partly due, however, to the violent friction of the parts and the application of counter-irritants used in the treatment, but cannot be wholly accounted for in this way. Herpetic eruptions along some of the peripheral branches are also occasionally seen.

Differential Diagnosis.

In dealing with any case it is important to ascertain, if possible, the exact site of the lesion. The previous history and surroundings of the patient should be carefully investigated, special stress being laid on possible injuries to the soft and hard structures in any part of the area of distribution of the nerve. The teeth should be examined by a skilled dentist, and old stumps removed. In women the condition of the uterus and ovaries, and the regularity or not of the menstrual functions should also be noted.

In spite, however, of the greatest care, it is often difficult to differentiate between central and peripheral neuralgiæ. Benedikt maintains that in central cases the pain is more lancinating, more widely diffused, localised in the bones and not limited to any particular nerve tracks, whereas in the peripheral variety the opposite conditions are present; this, however, cannot be relied upon from the

fact that a local lesion may morbidly react upon the nerve centres, and so make diagnosis impossible. Billroth suggested as a test, the employment of hypodermic injections of morphia, maintaining that if a tic persists in spite of three grains of morphia taken internally, or a quarter of a grain injected into the cheek, the neuralgia is certainly of peripheral origin.

If it be conceded that operative treatment in central neuralgia is useless, then the importance of ascertaining the locality of the lesion becomes manifest. I am not, however, prepared to say that in cases of central origin operative interference is of necessity unavailing, inasmuch as we cannot tell what reactionary influence of a beneficial character may follow the removal of the peripheral branches, especially when this is carried out with thoroughness and as near to the brain as possible.

Two theories have been adduced to explain the advantageous effect of operative treatment in these central cases. The first of these was propounded in 1830 by Bell, and has since received the weighty support of that distinguished neurologist Erb ; they maintained that the peripheral activity excited by the operation acts as a counter-irritant to the centres, and by its alterative and tonic effects assists in restoring them to a healthy state. If such be true, then severe and radical operations are entirely needless, and should be avoided ; a limited operation, such as nerve-stretching, which can be repeated as often as necessary, would be sufficient. The test of experience, however, has not confirmed this hypothesis, inasmuch as the repeated recurrences of pain have compelled surgeons to undertake more and more radical and heroic measures. The second theory, and that which seems more in conformity with the ideas and practice of the present day is that of Wagner, who maintained that the removal of the peripheral nerves presumably affected places the centres in a position of rest by excluding the afferent stimuli, and thus assisting for a time at least healthy repair in the centres. The logical deduction to be drawn from this doctrine is that the more extensive and radical the operations, the more likely are they to be attended with success.

Treatment.

It is not my intention to deal with the *medical* treatment of neuralgia, beyond a passing allusion to the more prominent of the drugs which have held for a time a reputation for alleviating or curing this complaint. Amongst these may be noted quinine, aconite, cocaine, chloral hydrate, croton-chloral, antipyrin, arsenic, paraldehyde, phenacetin, gelsemium, and the alkaline bromides and iodides. Locally aconite, belladonna, and menthol are commonly used, whilst blisters are also frequently employed. Many of these have undoubtedly proved beneficial; but probably few cases have been finally cured, when once the neuralgic habit has been fully established, except perhaps those owing their origin to syphilis, or some obvious and removeable cause. In all probability the cases which find their way to the surgeon are those in which medical treatment both local and internal has failed to relieve, and such patients have usually borne with their sufferings for many years before they seek surgical interference.

Hypnotism has of late years been much vaunted and had recourse to by French physicians as a curative measure, and a certain amount of success would appear to have followed its employment. Putting aside the ethical question as to the right of the physician to use such a remedy, it is difficult to understand how, if the neuralgia be due to organic lesion, the occurrence of pain can be prevented by a suggestion given during the hypnotic state.

In reviewing generally the *operative treatment* of this disease the first and simplest method employed, that of *Neurotomy*, although alluded to by Albinus and Galen, was first carried out on a branch of the 5th nerve about 150 years ago by Schlichting and Maréchal. It was performed more or less frequently up to 1840, and then for a decade or more seems to have fallen into disuse, if the silence of records is to be so interpreted. But in 1852, M. Roux of Paris, recorded four cases of operation on the 5th nerve, since which time they have become numerous enough. The plan usually adopted was that of introducing subcutane-

ously or under the mucous membrane a fine tenotome and dividing the nerve, whilst in a few cases the open method was employed. Transient relief followed in some instances, but not in all; and usually the neuralgic pain recurred at an early date with all its old severity. The cause of this is not far to seek, in that we now know how very readily divided nerves re-unite, and even when a portion of a nerve trunk is entirely removed regeneration of the destroyed portion is a matter of frequent experience. The scar itself, moreover, may become the exciting cause of the relapse, and may require extirpation. To prevent this reunion of the nerve, *Neurectomy* on a more extensive scale naturally suggested itself, and in this country it was performed by Abernethy in 1793. Even then insufficient portions of the trunks were removed, seldom more than half-an-inch, so that the regenerative energy of the nerve soon bridged over the interval and the pain recurred. Many other plans were suggested to obviate this. Thus in 1822, Klein crushed and cauterised the central end; Middledorpff, Bardeleben, and Luikart divided the nerve with the galvano-cautery; Boyer cauterised the peripheral end; whilst Malgaigne split one or both ends longitudinally, and turned them back in a loop, in other cases attempting to place a flap of soft tissue between the two ends. M. Péan more recently has recommended the old plan of removing the central end with cauterisation.

The results of all these earlier operations, whether neurotomy or neurectomy, were not satisfactory, as the following statistics will show:

Otto Weber (*a*) collected 100 cases with only 18 cures.

Wagner in 1869 recorded 135 cases (possibly including Weber's) and the results given were as under:

Cures after 3 years, 18.
Fatalities from sepsis, 6.

(*a*) Pitha and Billroth's "Handbuch," Bd. iii, Ab. i, Lief. i, p. 163.

In 1 case, relief for less than a month.
In 32 cases, „ „ months.
„ 20 „ „ „ 1-3 years.
„ 24 „ „ „ temporary, but the after-history was not known.

Dr. Fowler, of Brooklyn, (*a*) quotes 83 cases recorded since Wagner's list was published; but the statistics are of comparatively little value, as many of them were kept under observation for but a short time.

The regenerative energy of the nerve was shown, however, not to be the only cause of the relapses. Attention was directed to the important fact that so many of the branches of the nerve pass through bony canals and were thus more directly exposed to pressure; whilst it was also noted that during the period of life when these bony canals were relatively widest, *i.e.*, among children, neuralgia is practically unknown. The suggestion naturally followed that the nerves should always be divided on the proximal side of the canals.

In discussing the extent of the operation of neurectomy, it is eminently desirable to divide the nerve as high as possible, in order to get above any undiscovered lesion, whilst it is also advisable to remove as much of the nerve peripherally as is practicable in the affected locality in order the more certainly to place the nerve centres at rest by preventing stimuli from reaching the brain along anastomosing trunks. For example, the inferior dental nerve should be divided, not only at its entrance into the inferior dental canal, but also at its exit from the foramen ovale, and the intervening portion excised. The removal of a large extent of the nerve trunk was first suggested, I believe, by Professor Braun, as a means of dealing with the infra-orbital nerve; he advised its division at the foramen rotundum, aud also at the infra-orbital aperture, removing the whole of the intervening portion by traction. M. Beau, of Toulon, recommended a similar process to be adopted in the treatment of the inferior dental branch, dividing it at its entrance to the dental canal and at its exit from the mental foramen, removing the part between.

(*a*) *Annals of Surgery* (St. Louis), 1886, ii., p. 269.

But it was Professor Thiersch (*a*) who carried out this plan of *nerve-extraction* more thoroughly, and extended the operation to all the divisions of the trigeminal.

He frees the nerve from its connections at some spot easily accessible, and then by a process of torsion with specially constructed forceps is able to draw out a considerable length of it both distally and proximally, tearing the central end away, and cutting the peripheral. By this means very large portions of the nerve can be removed and so, it is hoped, recurrence of the neuralgia more effectually prevented. He recorded 28 cases of the operation in 1889 performed on 17 different patients, having operated eleven times on the infra-orbital, five times on the supra-orbital, four times on the inferior dental, thrice on the lingual, and once on the mental. Five or six centimetres can be removed from the supra-orbital; and he showed two specimens of the lingual nerve that had been extracted from the cadaver 9·5 and 15 centimetres in length respectively. Of the second specimen, 6 cms. were central, and 9 cms. peripheral measured from the angle of the jaw beneath which the nerve was grasped; and he calculated that it was torn through only one or two centimetres from the Gasserian ganglion. As to his results on the living subject, a marked degree of success attended his practice. Only one case had relapsed, and that in a very hysterical subject, although several of the operations had been performed six years previously. Paresis of the facial muscles had occurred temporarily in a few instances, and this is attributed to damage of the facial nerve terminals through the avulsion of the sensory twigs distributed with them.

The value of *Nerve-stretching* as a means of treatment was accidentaly discovered by Nussbaum, of Munich, in 1860, in consequence of the disappearance of a tetanic spasm of the arm after an accidental stretching of the ulnar nerve during resection of the elbow. In 1861 Hauser similarly by chance cured a contraction of the 4th and 5th fingers; and in 1869, Billroth (*b*) unintentionally cured a case of

(*a*) *Deutsche Gesell. f. Chirurg.*,1889, p. 44.

(*b*) *Archivs f. Klin. Chirurg.*, xiii. p. 379.

sciatica by the traction made during a thorough examination of the sciatic nerve. Nussbaum, however, reduced this plan of treatment to method, and first deliberately stretched the brachial plexus in 1874 (*a*), whilst Vogt in 1876 appears to have been the first to use it in trigeminal neuralgia. Since that date the operation has been largely employed, and its value has been pretty accurately ascertained in the treatment of the many conditions to which it has been applied.

Its use in cases of neuralgia has not been very satisfactory, and especially is this so in facial tic. Statistics are not of much value in the investigation of this subject, inasmuch as the cases were not kept under observation long enough. Hahn of Berlin records eleven cases, of which eight relapsed after six or eight months, two were utter failures, and only one case was really improved, although not cured, and in this a portion of the nerve was excised after being stretched. Lagrange gives similar unsatisfactory accounts of the operation of stretching the supra-orbital nerve; out of fifteen cases, there was but one known cure after three years, and five were quite unsuccessful; in one, there was but temporary relief, and the subsequent history of the other cases is not recorded. Of six neurectomies of the same nerve, four were successful. The same author contrasts neurectomy with nerve-stretching of the infra-orbital branch; whilst with the former 25·67 per cent. of the cases remained free from pain after three years, only 12·57 per cent. of those in which the nerve was stretched, were free at the same time.

Practically it is now admitted by almost all surgeons that nerve-stretching should be retained as a means of dealing with neuralgia of mixed nerves only, and undoubtedly it is beneficial in some such cases. But with the fifth nerve which is almost entirely sensory, no permanent relief can be expected from the operation, and neurectomy is in every way to be preferred.

Probably, however, in all cases of neurectomy, a certain amount of stretching of both central and peripheral ends

(*a*) *Deutsche Zeits. f. Chirurg.*, 1874.

accompanies the manipulations necessary to free the trunks, and it is a perfectly open question as to whether or not such traction has any beneficial effect or otherwise on the course of the disease. That central changes can result therefrom is now a fact tolerably well established in those instances where the nerves pass directly through short, straight canals to the central organ. Thus Dr. Pauline Tarnowski, in the "Archives de Neurologie" (May and July, 1885) has reported the results of experiments made by him on rabbits. The sciatic nerves were stretched, and the spinal cords carefully examined at varying intervals of time. If slight traction alone was employed (*e.g.*, 500 grammes), the only change found was a transient hyperæmia which soon passed away. But when the force reached 4 or 5 kilogrammes, more definite changes occurred; in the grey matter hæmorrhages and inflammatory exudations were seen soon after the injury, and later on sclerosis with atrophy of the nerve cells, such changes being always more marked in the posterior than in the anterior cornua. It is quite possible that similar effects may be produced in the Gasserian ganglion by stretching the branches of the second and third divisions, but evidently sufficient curative effect is not thereby established.

One other plan of treatment which has been suggested must be alluded to ere I bring this lecture to a close, viz., *Ligature of the Carotid Artery.* It was originally recommended and practised by Trousseau; but up to the present time, so far as I can ascertain, only eighteen cases have been thus treated, and the results as given by Dr. Fowler have been as follows:—

In 4 cases, there was relief for over 3 yrs.
„ 3 „ „ „ „ 1—3 yrs.
„ 4 „ „ „ „ 1 yr.
„ 1 „ partial relief.
„ 2 „ no relief.

One case was fatal. The longest period of relief was eleven years, but it must be noted that some of the reported cures had also been treated by nerve-stretching and exci-

sion. Roser is stated by Madelung (*a*) to have tied the external carotid for tic thrice, with one cure.

Of this plan I have had no experience, and, indeed, have heard of no cases in which it has been recently tried; but one cannot help being struck by the above results, especially in connexion with the theory of obliterative endarteritis, alluded to earlier in this lecture propounded by Prof. Dana. The figures quoted indicate a measure of success which is certainly somewhat greater than that usually attending operations directed to the nerves themselves.

The mortality of the operation is certainly a serious objection to it, for although it is less than when the artery is tied for aneurisms, etc., yet Hüter calculates it as about 5 per cent. in these cases, and such a fact would exclude it as a means of treatment, except as a last resort. Moreover, even if not fatal, the possible effect upon the cerebral hemispheres must not be lost sight of. That death has occurred from neurectomy is an undoubted fact, but this is usually explained by septic contamination of the wound which can be avoided, and I am thankful to say that I have not yet lost a case in any of my nerve operations. (*b*) If, however there should be a recurrence of the pain after dealing with the Gasserian ganglion this operation of carotid ligature can still be resorted to.

(*a*) *Archivs. f. Klin. Chir.*, xvii.

(*b*) Since this lecture was written, I have to record one fatal case resulting from an operation on the Gasserian ganglion, for details of which see page 83.

LECTURE II.

1*st. Division.* — Supra-Orbital Nerve. — Supra-Trochlear Nerve
2*nd. Division.*—Infra-orbital Nerve.—Removal of Meckel's Ganglion.
3*rd Division.*—Inferior Dental Nerve.—Gustatory Nerve.—Division of Trunk at Foramen Ovale.

MR. PRESIDENT AND GENTLEMEN—

IT is my intention to devote this lecture to a consideration of the various operations on the different branches of the 5th. nerve, passing each procedure rapidly under review. For the efficient performance of these it is essential for the surgeon to be well acquainted with the topographical anatomy of the face, and the various landmarks which serve as guides to the position of the nerves and arterial trunks. No apology therefore is necessary for introducing a brief anatomical sketch of each of the divisions of this nerve, previous to discussing the various operative methods.

The 1*st. or Ophthalmic division,* after coursing along the outer wall of the cavernous sinus as a flattened band enters the orbit through the sphenoidal fissure, dividing into three branches, the frontal, lachrymal, and nasal. The last two of these are of but slight surgical importance, and I shall not therefore allude to them. The frontal nerve, which forms the largest portion, divides into the supra-orbital and supra-trochlear, and both of these come within the domain of surgical treatment; consequently their exact position is of importance.

The *supra-orbital* nerve (Fig. 7, *a*) emerges from the orbit at the foramen or notch at the junction of the middle and inner thirds of the supra-orbital margin. It is accompanied by vessels derived from the ophthalmic artery and vein; the trunk of the nerve lies beneath the orbicularis palpebrarum, and is distributed to the forehead and anterior portion of the scalp. The notch, if present, forms a sure guide to the position of the nerve, which can be reached and exposed by a vertical incision immediately over it, as recommended by Sir William MacCormac, or by a transverse incision parallel to and a little below the eye-

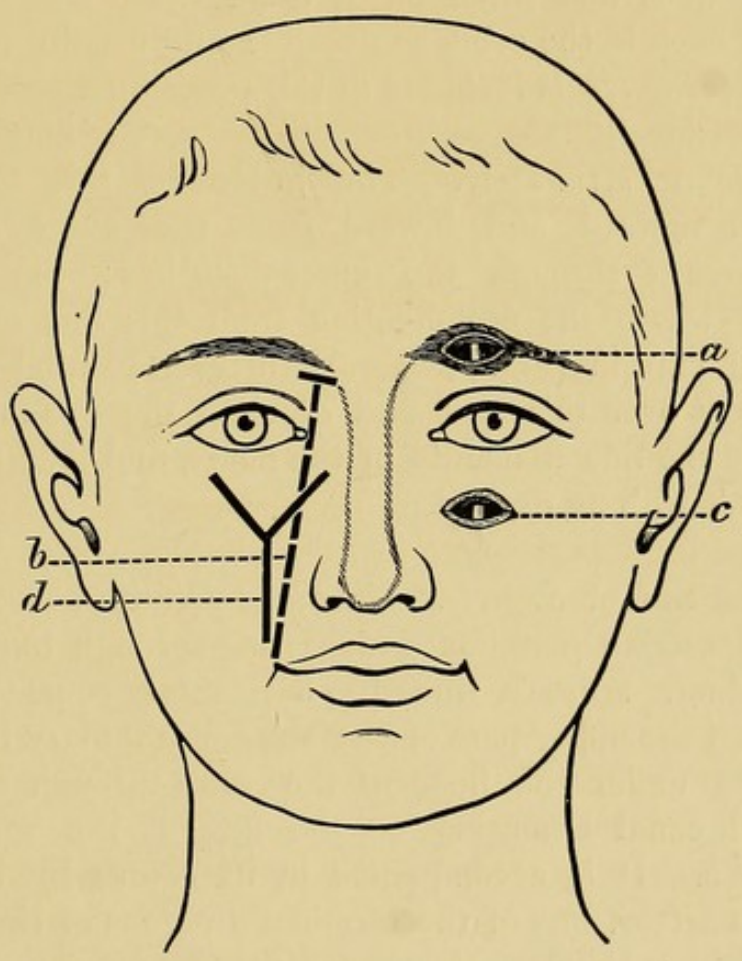

FIG. 7.—Diagram of full face, showing :—

(*a*) Position of supra-orbital nerve, and incision exposing it.

(*b*) Line indicating position of supra-trochlear nerve, passing from angle of mouth through the inner canthus. The short crossline at its upper end is the position of the incision required to expose it ;

(*c*) Position of the infra-orbital nerve, and incision ;

(*d*) Carnochan's incision for neurectomy of the 2nd division.

brow, as more commonly practised. The latter method leaves a less noticeable scar, whilst the former gives access to a larger portion of the nerve. Whatever the direction of the skin incision, the knife should afterwards be carried in a direction parallel to the fibres of the orbicularis. The old subcutaneous operation is now seldom practised, being unsatisfactory, mainly owing to extensive extravasation from concurrent division of the supra-orbital vessels.

When neurectomy is necessary, the orbit must be entered by dividing the orbito-tarsal ligament, the orbital fat depressed by a spatula, and the nerve freed from its connections and lifted on a blunt hook. It is divided as far back in the orbit as possible, and usually the supra-trochlear nerve is included in this procedure.

Occasionally the *supra-trochlear* nerve may demand treatment separately. The guide to this is a line drawn upward and inward from the outer angle of the mouth through the inner canthus; the nerve is found where the prolongation from this line meets the orbital margin (Fig. 7, *b*). An incision parallel with the eyebrow over this spot and dividing the orbicularis will expose the fine filaments of the nerve, and they may then be dealt with as desired.

The *2nd.* or *Superior Maxillary Division*, after leaving the Gasserian ganglion and passing through the foramen rotundum, takes a directly horizontal course forward through the upper part of the spheno-maxillary fossa, and onward under the floor of the orbit through the infra-orbital canal emerging on the face at the infra-orbital foramen. It is accompanied in its course by the infra-orbital artery, one of the terminal divisions of the internal maxillary; this vessel, often a trunk of some size, may give considerable trouble in operations in this region. The situation of Meckel's ganglion and the point where the posterior dental nerves come off is a little under 2 inches from the infra-orbital foramen; consequently to excise the former and divide the latter requires a somewhat deep dissection. The upper wall of the antrum is an important inferior relation, for the nerve is only separated by this

from the antral cavity. The infra-orbital canal is in many skulls open above in its posterior half, constituting merely a groove; the anterior half inch is, however, invariably a true bony canal, which takes a somewhat downward as well as forward course. All the teeth of the upper jaw are supplied from this division; the molars, by the posterior

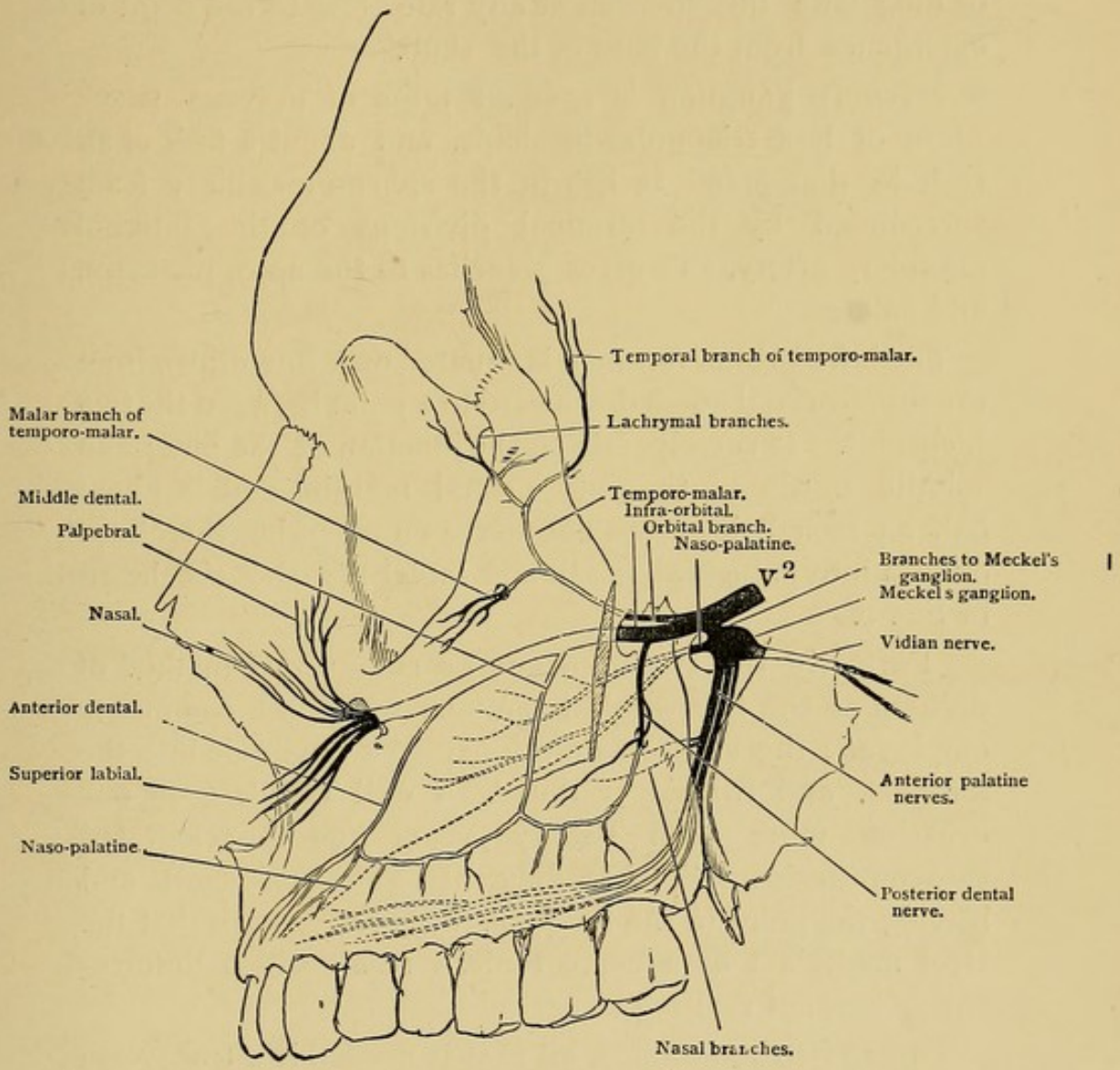

FIG. 8.—Distribution of the 2nd. or superior maxillary division of the fifth nerve. (*MacCormac.*)

dental branches arising close to Meckel's ganglion between it and the point of entrance into the infra-orbital canal; the bicuspids and canines are supplied by the middle dental offshoots which leave the main trunk in the hinder part of the canal, whilst the anterior dental branches supplying

the incisors arise in the canal close to the infra-orbital foramen. An orbital branch is given off before Meckel's ganglion is reached, just external to the foramen rotundum, and this is distributed to the skin over the temporo-malar region, where neuralgia may be felt. The high origin of these nerves emphasises the importance of dealing with this division at any rate close to the point of emergence from the base of the skull.

Meckel's ganglion is a small mass of nervous tissue more or less triangular in shape, and about a fifth of an inch in diameter. It lies in the spheno-maxillary fossa surrounded by the terminal divisions of the internal maxillary artery, and gives branches to the nose, pharynx, and palate.

The infra-orbital foramen is situated on a line drawn from the supra-orbital notch downward to a point between the two bicuspids. It corresponds to the junction of the inner and middle thirds of the infra-orbital margin, and is about half an inch below it. The nerve on emerging therefrom divides into palpebral, nasal and labial branches, as shown in Fig. 6.

Formerly the subcutaneous or submucous method of division at the infra-orbital foramen was most commonly employed; the surgeon simply passed a tenotome into the foramen, and twisted it round. I well recollect on one occasion more than twenty years ago a celebrated surgeon accidentally breaking his knife off short and leaving the point in the foramen, with the remark that the steel might act as a nerve tonic, a result which unfortunately was not realised.

To expose the foramen, all that is needed is a transverse incision extending through the orbicularis and separating its fibres. The margins of the wound must then be held apart with blunt hooks or spatulæ, and by a careful dissection the nerve is seen emerging from the foramen. Half an inch of it can be removed by this procedure. (Fig. 7.)

In order to expose and excise larger portions of this nerve, three distinct plans have been suggested and prac-

tised, which may be named respectively, the *orbital*, the *antral*, and the *pterygo-maxillary*.

(*A*) The *orbital* method.

Several different operations may be included under this heading, notably Langenbeck's and Wagner's. In the former, the infra-orbital foramen is first exposed by a transverse incision, and the nerve freed at its point of exit, and secured by forceps. Dieffenbach's tenotome, a narrow-bladed, slightly curved or hooked knife, is now entered, with its cutting edge directed downward close to the external canthus, just below the outer palpebral ligament, and is passed backward toward the apex of the orbit along the anterior border of the pterygo-maxillary fissure, which is crossed by the nerve about an inch behind the orbital margin. Care must be taken to keep it close to the bone, and not to insert it too far, lest the spheno-maxillary fossa be entered and serious hæmorrhage result. By now withdrawing the knife carefully, and keeping its edge closely applied to the bone the nerve can be divided as it enters its canal. Traction or torsion upon the peripheral end will enable the whole length of the nerve to be removed and the dental branches given off in its course to be torn through. Malgaigne (*a*) made a similar preliminary incision, but divided the nerve as it entered the canal by passing a tenotome along the floor of the orbit. The great objection to both of these proceedings is the hæmorrhage which results from an indefinite division of vessels in a situation inaccessible for ligature, and the uncertainty which necessarily attends the use of a knife at such a depth when the surgeon is, so to speak, working in the dark. In the present day with the confidence gained by experience in the use of antiseptics, open operations should usually be adopted in preference to subcutaneous methods, which latter must of necessity be uncertain, and lacking in precision, and especially so when the structures to be divided are in dangerous localities.

With a view of obviating this, *Wagner* introduced

(*a*) *Manuel de Medical Operations*, 4th edition, p. 153.

a different plan. He raised the orbital contents from an incision running transversely below the orbital margin, laid open the infra-orbital canal with a chisel, separated the artery from the nerve with a special aneurism needle having a lateral curve, and divided the nerve *behind* the origin of the dental branches. It appears to me that this operation could be conducted with greater facility if more space were obtained by a freer use of the chisel, trephine, and other suitable instruments; and considering the close proximity of Meckel's ganglion, it is better surgery to extend the operation to its removal, as the gain will probably be more decided without any considerable increase in its severity. The value of this additional proceeding is evidenced statistically by the report given by Dr. Fowler of Brooklyn (*a*), who records 83 cases dealt with, and contrasts the results of 26 in which the ganglion was removed with those of 26 in which it was left behind. In the former series where the ganglion was removed, three patients obtained relief for more than 3 years, six for 2-3 years, nine for 1-2 years, and eight for under 12 months. Of the 26 where the ganglion was left, five obtained relief for over 3 years, three for 2-3 years, seven for 1-2 years, and eleven for under 12 months, and he calculates that the average period of relief was 1 year, 5 months, and 16 days when the ganglion was removed, and 1 year, 3 months, and 15 days when the ganglion was left intact. From these statistics the gain derived from removal of the ganglion is not so great as we should expect, but yet one cannot but feel that it is correct practice to deal with it by extirpation. I fear it must be admitted that all operations for the relief of tic of the second division of the fifth nerve are unsatisfactory.

In his recent paper Professor Horsley (*b*) has described his plan of operating which is practically the same as Wagner's. The eyelids are stitched together as a preliminary precaution. His incision is a semilunar one along the inferior orbital margin, combined with a vertical one

(*a*) *Annals of Surgery*, St. Louis, III, 1886, p. 269.
(*b*) Horsley, *Brit. Med. Journ.*, Nov. 28, 1891.

placed at right angles to it over the infra-orbital foramen and about three-quarters of an inch in length. The flaps thus marked out are raised from the bone, the periosteum being included. The orbital tissues are now freed from the bone, and emphasis is laid on the fact that if the orbital periosteum be maintained whole and unbroken, the orbital fat is not seen and does not protrude into the wound. The infra-orbital canal is laid open with a fine pair of bone forceps, and as a rule the antrum remains intact. Should it be accidentally opened its cavity is to be filled with powdered boracic acid, and no interference with the healing of the wound is to be expected. The nerve is freed as far as the foramen rotundum and there divided.

B. The *antral* method was devised and originally introduced by Carnochan (*a*) of New York, in 1858, in order to effect removal of Meckel's ganglion which he considered to be of great importance. Twenty-two cases of the operation were collected and brought before the Royal Medico-Chirurgical Society of London in 1884 by Chavasse, who had himself performed the operation several times, introducing slight modifications in the technique.

Carnochan's incision was V-shaped with the apex over the infra-orbital foramen pointing downwards (Fig. 7, *d*); each limb of the V should be about one inch long. The flap thus marked out is turned up and held out of the way, and a vertical incision made from its apex to the angle of the mouth opening into the oral cavity. This permitted the infra-orbital nerve to be well-defined and set free, and the anterior wall of the antrum clearly seen.

Chavasse proposed the use of a T-shaped incision, the transverse limb being made parallel to the fibres of the orbicularis, and the vertical limb extending nearly to the angle of the mouth, but not opening it. Sufficient room is gained by this means; but for the later steps of the operation an efficient electric incandescent lamp is most essential, and a small hand-lamp in a bell-shaped reflector

(*a*) *American Journal of Medical Science*, 1858, p. 136.

held by an assistant in any position the operator may desire, will best serve this purpose; some surgeons, however, prefer the lamp to be fixed to the forehead. The anterior wall of the antrum is next opened, either by a half-inch trephine, or with a chisel and mallet, as suggested by Mr. Treves, the mucous lining torn through, and the cavity fully exposed. The posterior wall of the antrum is perforated in a similar way, either by a quarter-inch trephine (Chavasse) or by a chisel (Carnochan). The spheno-maxillary fossa is thus reached and profuse hæmorrhage must be expected, which should be checked as far as possible by sponge pressure. The infra-orbital canal is then opened along the roof of the antrum by incising the mucous membrane, and picking away the bony walls of the canal with a chisel or fine bone forceps. If the nerve be seized in a pair of catch forceps, this proceeding will be facilitated; and thus the nerve can be gradually traced back into the fossa, and up to the foramen rotundum. At this stage the infra-orbital vessels usually give trouble. The trunk of the nerve can now be divided close to the foramen by a pair of fine curved blunt-pointed scissors; Meckel's ganglion is defined lying a little below the nerve in the fossa, and removed; and the posterior dental branches are torn or cut through. It is not always easy to see the ganglion, and occasionally its removal is from this cause a matter of guess-work, for the hæmorrhage may be so severe as to prevent any clear vision of the parts. Bleeding having been arrested by sponge pressure, etc., the wound is thoroughly washed out and closed; a small drainage tube can be inserted with advantage into the lower angle of the V.

The results of this operation are not on the whole encouraging, for in Chavasse's collection of 22 cases, only three seem to have derived permanent benefit. Of five cases similarly treated by Mr. Treves, one experienced a recurrence of the neuralgia at the end of three years, one at the end of two years, two within twelve months, whilst the fifth died of cancer within six months.

Von Bruns (*a*) and Otto Weber (*b*) modified this operation of Carnochan's by making a semilunar incision along the infra-orbital margin, raising the orbital tissues, freeing the infra-orbital nerve at its foramen, and then with a fine saw cutting in a circular direction around the foramen at a distance of half a centimetre. This must extend backwards as far as the spheno-maxillary fissure, and the bone must be completely detached so that it may be slipped over the nerve, and thus the fossa freely opened. The remaining steps of the operation are the same as in Carnochan's.

(*C.*) The third means of dealing with this division of the fifth nerve is the *Pterygo-maxillary operation*, originally practised by Professor Lücke (*c*). He made an oval incision extending from the outer canthus first backward, and then downward and forward; the masseter muscle was then detached from the lower border of the zygoma, and turned down, whilst the zygoma itself was sawn through in front and fractured behind, so that it together with the temporal fascia attached could be turned upwards. By carefully dissecting down in front of the tendon of the temporal muscle the nerve was reached and divided as it crossed the spheno-maxillary fossa, the parts were then replaced, the masseter being sutured to the zygoma. The results of this method of dealing with the zygoma were extremely unsatisfactory from the fact that the muscle usually did not unite with the bone, and hence cicatricial deformity and functional weakness were produced. Professors Braun (*d*) and Lossen (*e*) have introduced a plan to obviate this by detaching the temporal fascia from the bone, and turning the latter downward together with the masseter. The incision employed is angular (Fig. 9, *a*), starting from just behind and below the external angular process of the frontal bone backward to the tragus, and downward and forward into the cheek. A flap of skin and subcutaneous tissue is reflected; the zygoma divided in front and behind, and

(*a*) Von Brun's Atlas, Abth. II, Taf. XV, fig. 10.
(*b*) Otto Weber, op. cit., p. 166.
(*c*) *Deut. Zeitschritt f. Chirurg.*, June 9, 1874.
(*d*) *Cent. f. Chirurg.*, 1882, No. 16.
(*e*) *Cent. f. Chirurg.*, 1878, p. 65 and 148

turned down ; the tendon of the temporal muscle is drawn backward with the mouth slightly open. The pterygo-maxillary fissure is in this way exposed, and the nerve sought for in the fossa and divided (Fig. 10). This procedure removed one of the objections to reaching

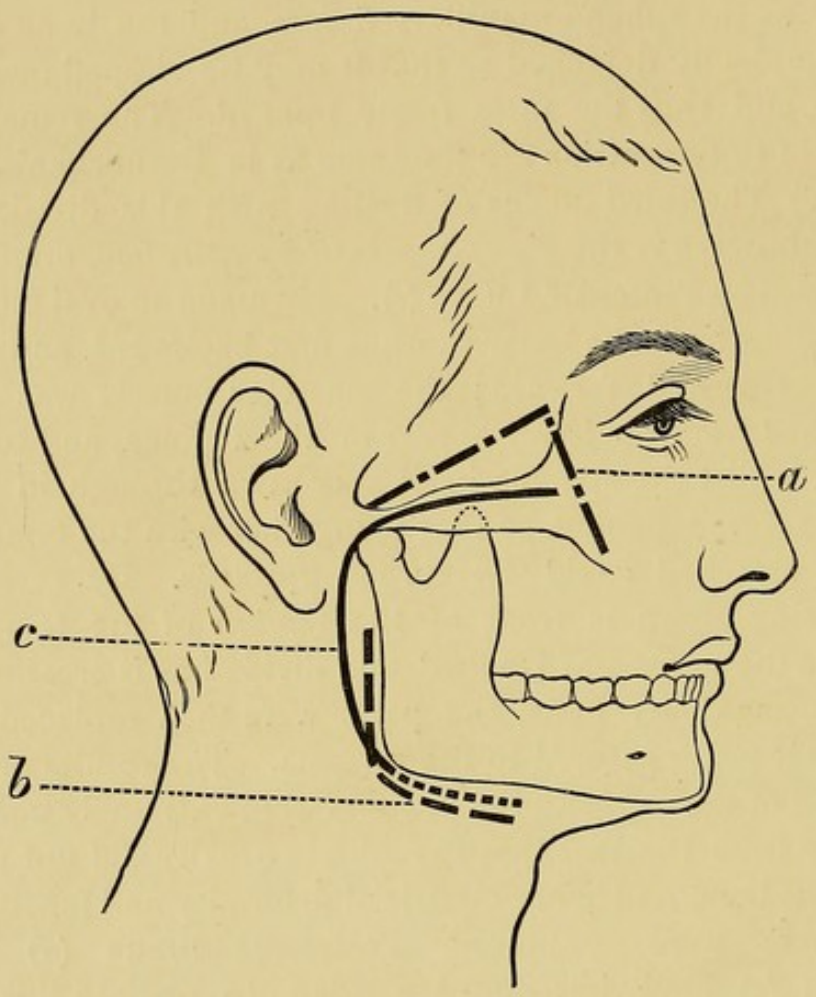

Fig. 9.—Diagram of side of face showing :—

(*a*) Incision in the Braun-Lossen method of reaching the 2nd division of the fifth nerve at the foramen rotundum ;

(*b*) Lücke-Sonnenburg incision for exposing the foramen ovale ;

(*c*) My own incision for deepening the sigmoid notch. The dotted extension represents the additional incision needed in operating for the Gasserian ganglion.

Meckel's ganglion by this route, but in order to remove the infra-orbital nerve it is necessary to make an additional incision over the site of the infra-orbital foramen (Fig. 10, *d*). The great advantages which are claimed for this operation

are that the cicatrix will be less obvious on looking at the patient full-face, and the hæmorrhage will be diminished in that the internal maxillary artery can be secured before the fossa is reached. Moreover, the antrum is not opened, and hence the risk of septic contamination of the wound is considerably lessened.

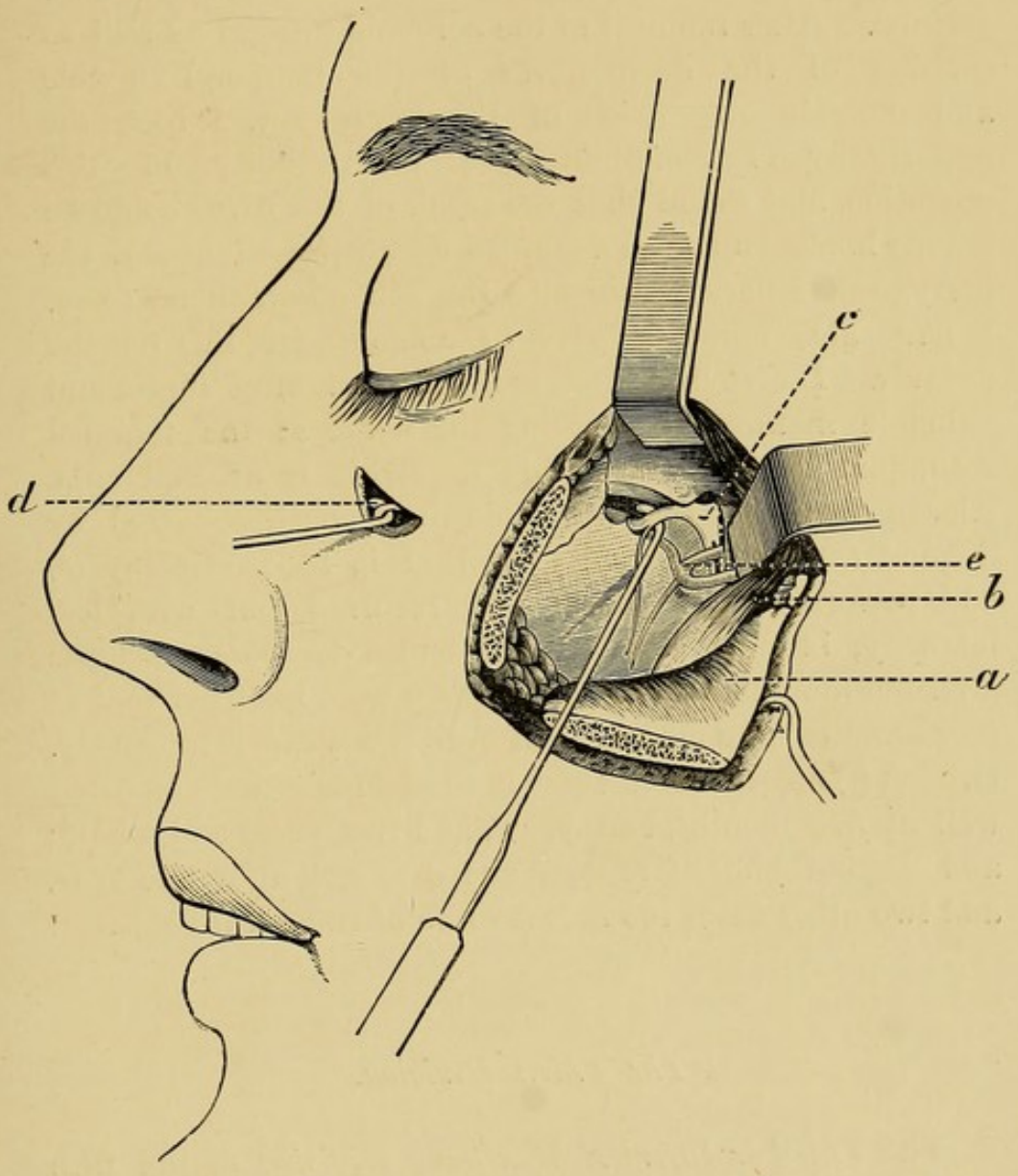

FIG. 10.—Diagram showing dissection necessary to expose the 2nd. division of fifth nerve, according to the Braun-Lossen method.

(*a*) Zygomatic arch divided and turned down ;

(*b*) Temporal tendon, arising from coronoid process, and held back by retractors ;

(*c*) Superior maxillary nerve and Meckel's ganglion ;

(*d*) Infra-orbital nerve at the emergence from the canal.

Since writing the above I have had occasion to operate upon a case of long-standing ankylosis of the lower jaw, for which I thought it desirable to excise the coronoid process on the affected side. The preliminary steps of the operation were very similar to those detailed above, with the addition that I drilled the zygoma before and behind for subsequent wiring, and made use of a different skin incision. After removal of the coronoid process as well as division of the deep fibres of the temporal muscle and forcible depression of the lower jaw, I took the opportunity of examining the practicability of this operation, and found that the trunk of the nerve could be readily hooked up on an aneurism needle passed through the pterygo-maxillary fissure into the spheno-maxillary fossa. I have also found it easy to demonstrate this on the cadaver. I certainly think that this is a most direct and valuable method of reaching the nerve at the foramen rotundum if it be desirable to divide it at that spot. Eleven cases of this operation have been collected by Segond (*a*), and the results reported in 1890. Czerny (*b*) had performed five cases; one recurred, but with less intensity, in nine months; one had a temporary relapse after ten months, and the other three were reported well at four months, nine months, and over two years respectively. Grisson (*c*) records three cases in Madelung's clinic reported well at five months, two years, and two years and a half; and Segond himself reports one case well after one year, and two other cases too recent to be of statistical value.

The Third Division.

The *Third or Inferior Maxillary Division* of the fifth nerve as it emerges from the base of the skull through the foramen ovale is joined by the motor root, and divides immediately into two trunks. The anterior or

(*a*) *Revue de Chirurg.*, 1890, March 10.
(*b*) *Deutsche Zeitschritt f. Chirurg.*, 1882, No. 16.
(*c*) *Berl. Klin. Wchshrtt.*, 1887. Dec. 21.

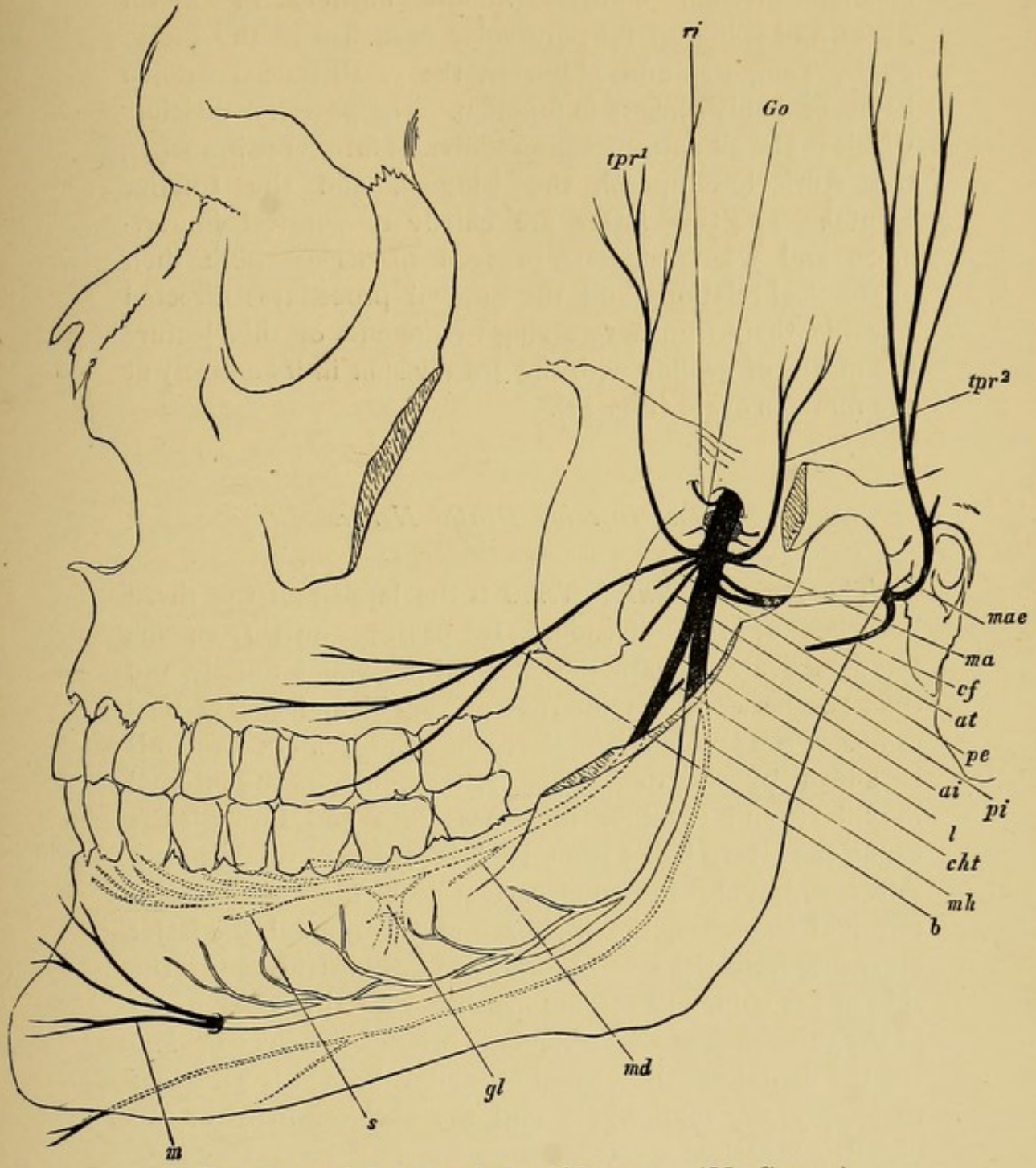

FIG. 11.—3rd division of the fifth nerve. (*MacCormac*).

tpr[1]. Anterior temporal branch.
ri. Recurrent branch.
Go. Otic ganglion.
tpr[2]. Posterior temporal branch.
mae. Branch to meatus auditorius externus.
ma. Masseteric branch.
cf. Communicating branch to facial nerve.
at. Auriculo-temporal.
pe. Nerve to external pterygoid.
pi. Nerve to internal pterygoid.
ai. Inferior dental.
l. Lingual.
cht. Chorda tympani.
mh. Mylo-hyoid branch.
b. Buccal branch.
md. Branches to the mucous membrane.
gl. Submaxillary ganglion.
s. Branches to the submaxillary gland.
m. Mental branch.

smaller division consists almost entirely of motor fibres, and splits up into muscular branches to the Pterygoids, Temporal and Masseter, the small Buccal branch being probably sensory in function. The posterior division, which is almost entirely sensory, divides into three branches, the Auriculo-temporal, the Lingual, and the Inferior Dental. The two latter are chiefly of surgical importance, and we must now proceed to discuss both their anatomical relations and the surgical procedures directed towards their trunks, reserving to the end of this lecture the means of dealing with the 3rd division in its entirety at the foramen ovale (Fig. 11).

The Inferior Dental Nerve.

The *Inferior Dental Nerve* is the largest of the three branches of this division. It passes down from the foramen ovale beneath the external pterygoid muscle, and then lies between the internal pterygoid and the vertical ramus of the jaw. When it reaches the dental foramen it is joined by the dental artery, a branch of the internal maxillary, and together they pass into and through the canal, the artery being superficial or external to the nerve. After supplying the molar teeth, it divides into two terminal branches, the incisor and the mental, the latter emerging from the mental foramen to be distributed to the skin of the chin, and communicating with the facial nerve in the substance of the orbicularis oris. Previous to entering the dental canal, a small muscular branch is given off to supply the mylo-hyoid and the anterior belly of the digastric muscles.

It may be exposed in three situations, viz., at its exit from the mental foramen, in the dental canal, and above the dental canal.

At its exit from *the Mental foramen* it may be divided by a submucous operation. Its position is easily ascertained, viz., below and between the bicuspid teeth. The operation, however, is not to be recommended, as the pain invariably returns.

The nerve can be reached *in the Dental canal* by removing a disc of bone comprising the outer layer of the jaw by means of a three-quarter inch trephine applied over its course about the junction of the ascending and horizontal rami. If the disc be skilfully removed, the nerve and the artery can be seen running together in the bone, and the former lifted up on an aneurism needle, whilst it is well to divide the latter between a double ligature. The skin incision should be made along the line of the jaw, and about ½ inch behind it, never over the part to be trephined. By this means the cicatrix is less evident, and the wound in the skin does not correspond with that in the bone.

Another somewhat similar method of dealing with the nerve is that of Velpeau, who through the same kind of incision trephined the jaw through the ascending ramus, immediately over the dental foramen. At this spot the bone is much thicker below than above, and hence the trephine should not be used when the upper part of the jaw has been divided; the remaining half circle of bone is best detached by means of an elevator and chisel.

Linhart operates in much the same way, but detaches the masseter by a vertical incision which is liable, I should fear, to divide all the branches of the facial nerve in that locality, and consequently lead to paralysis and subsequent facial disfigurement.

Gross has recommended the use of the dentist's drill as a means of destroying the nerve in the canal by perforating the bone over the course of the dental canal, thus cutting the nerve across.

These operations are extremely easy, and the wounds heal without trouble. The results, however, are not lasting, the pain returning after an interval varying from a few months to a year. I have, therefore, entirely abandoned this method of treating cases of neuralgia of this nerve, and always have recourse to higher operations.

The Inferior Dental Nerve has been attacked *just above* its entrance to *the dental canal* in the lower jaw by three different methods, which we may fairly describe as—

(*a*) the Intra-buccal method;
(*b*) the Retro-maxillary; and
(*c*) the Trans-maxillary.

The *Intra-buccal* method is the form the operation originally took; it was proposed by Lizars, and performed for the first time by Michel (of Nancy) in 1856. More recently it has been again advocated by Billroth, but it is commonly known as Paravicini's operation.

The nerve lies close under the mucous membrane of the mouth for about an inch of its course after getting clear of the internal pterygoid muscle, and then runs between the internal lateral ligament of the temporo-maxillary joint on the inside, and the ramus of the jaw externally. The gustatory nerve pursues a parallel course a little internal and anterior to it. The dental foramen is guarded at its anterior and inner aspect by a sharp osseous projection, the *lingula* or spine of Spix.

The intra-buccal operation is performed as follows:—

The mouth is opened with a gag, preferably unilateral, placed between the molar teeth on the opposite side. The cheek on the affected side is held well out of the way with retractors, and if necessary, the tongue pulled to the opposite side with forceps. It is now tolerably easy to define the entrance to the canal, and feel both nerve and artery rolling under the finger. The spine of Spix cannot be so clearly distinguished as on the skeleton from the fact that it is obscured by the attachment of the internal lateral ligament. The mucous membrane is incised over the anterior border of the ascending ramus of the jaw in a vertical direction for about one inch, and this incision must be carried down to the bone. The soft parts must next be detached from the jaw, and in order to reach the orifice of the canal the internal lateral ligament will need division; this may be done by means of a fine pair of blunt-pointed scissors, such as are used in strabismus operations. The nerve can now be seen, and isolated from the vessels; it is freed from its connections as far up as possible, and divided, care being taken not to wound the internal maxillary artery by going too high. It is again

divided close to the foramen, and the intervening portion removed; this will only consist of about half an inch. Of course a good electric light is absolutely essential.

This operation is admittedly objectionable from many points of view. In the first place, we have a wound communicating with the mouth, which is always undesirable, and one of Michel's cases died of septicæmia, as a result. Then again only a very limited portion of the nerve can be excised (Billroth says, 1 inch), and moreover from the cramped space the proceeding is very difficult. Hæmorrhage from a wound of the inferior dental artery is not an uncommon accompaniment, and when it occurs it is not easy to deal with from the inaccessibility of the parts; in consequence of this, the external carotid has, I understand required ligature more than once.

The *retro-maxillary* operation, or as it is commonly called, the Lücke-Sonnenburg method, after the two surgeons who originated it, is described by Ullman, who has recently advocated its use, as follows:—

The head is allowed to rest on the sound side, or even hanging over the end of the operating table. An incision is made along the posterior border of the jaw, and from 1·5 cms. above the angle to the centre of the horizontal ramus (Fig. 9, *c*). The branches of the facial nerve to the neck are the only ones of importance divided, but the facial vessels will of necessity be divided and need to be ligatured. The parotid fascia is next incised, and the gland drawn upward as far as possible. The internal pterygoid muscle is detached by scissors from the mandible, and the entrance to the inferior dental canal is indicated by the spine of Spix which should be carefully sought for. The nerve is isolated and divided with scissors peripherally; it is held tense with forceps and serves, if necessary, as a ready guide to the foramen ovale.

The *Trans-maxillary Operation* is that which promises to be the most effectual, and is, perhaps, that most generally adopted in the present day. It is usually accomplished by deepening the sigmoid notch. Inasmuch, however, as the lingual nerve can also be dealt with by this method, and since both nerves usually need simultaneous division

close to the base of the skull it will be well to defer the description of this operation till we deal with the different methods of reaching the trunk of the nerve at the foramen ovale.

The Lingual Nerve.

The *Lingual Nerve* lies in the first place beneath the external pterygoid muscle together with the inferior dental, but is internal and a little anterior to it. It then passes between the internal pterygoid muscle and the inner side of the vertical ramus of the lower jaw crossing obliquely above the superior constrictor of the pharynx to reach the side of the tongue. In this part of its course it lies immediately beneath the mucous membrane of the mouth, and can be readily felt at a point corresponding to the junction of the middle and upper thirds of a line drawn between the angle of the jaw and the last molar tooth. It thence courses forward to the apex of the tongue lying superficial to the hyoglossus muscle, crossing Wharton's duct.

It can be easily reached through the mouth by incising the mucous membrane if it be thought desirable. The cheek must be held aside by a broad retractor, and the mouth kept open by an efficient gag. Sir William MacCormac recommends the division of the cheek also, but this is surely an undesirable addition, particularly as the operation is itself usually ineffectual. The nerve is seen passing downward and forward, and can be raised on a blunt hook and stretched or divided. About one inch of it may be removed in this manner. There are many objections to this proceeding; in the first place, the nerve is reached at some distance from its exit from the skull; secondly, troublesome hæmorrhage may obscure the part, and render the operation very difficult; and lastly, it is impossible to keep the wound aseptic. Although I used to practise this method in my earlier cases, I have long discontinued it in favour of the external operation by which means perfect asepsis can be maintained, and the trunk of the nerve divided close to the base of the skull. Moreover, the branches of the inferior

dental are frequently affected as well, so that it is better to deal with the two together by the operation of deepening the sigmoid notch. In cases of malignant disease of the tongue where the pain is very severe, it may be occasionally useful to reach and divide the nerve in this way through the mouth; but as a rule more extensive operative procedures are necessary.

It has also been suggested by Luschka to reach the lingual nerve through the submaxillary region by an operation very similar to that for tying the lingual artery. An incision is made along the lower border of the horizontal ramus, the cervical fascia divided, and the submaxillary gland drawn forward and downward. The digastric will thus be exposed lying anteriorly upon the mylo-hyoid, and held down by fascial attachments to the body of the hyoid bone. The hyo-glossus muscle is also seen, extending vertically upwards, and the lingual nerve crossing its outer surface at its highest part can there be divided. The depth at which the nerve lies is the great difficulty in dealing with it in this way, and is a serious bar to the adoption of the operation. Even when the nerve is reached, only a small portion can be removed, and that at a considerable distance from the foramen ovale.

The nerve can also be reached by the Lücke-Sonnenburg method described above, the inferior dental being included in the same operation, if necessary; and Löbker has operated by making a curved incision along the antero-inferior border of the masseter muscle, and then by chiselling away the anterior border of the ascending ramus of the lower jaw, the lingual nerve can be seen and dealt with, lying on the outer surface of the internal pterygoid.

The want of success attending these methods of dealing with the peripheral branches has led surgeons to extend the scope of their operations to the base of the skull, hoping by a division of the nerve at its point of emergence and by a more extensive removal of the nerve trunks to obtain results of a more permanent character.

Division of the Nerve at the Foramen Ovale.

Previous to describing the different methods of reaching the foramen ovale, which have been proposed and practised, it may be well to examine its chief anatomical relations.

Surgical Anatomy.—The foramen ovale is an aperture

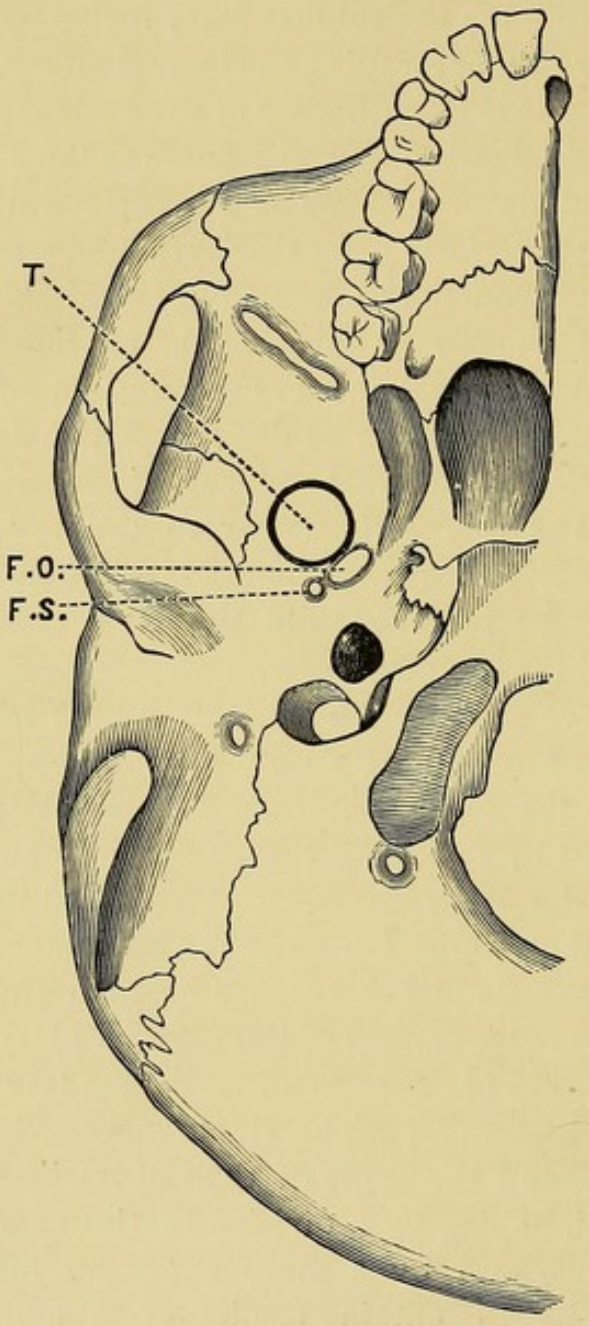

FIG. 12.—Diagram of base of skull, showing relations of the foramen ovale.

fs. Foramen spinosum. | *fo.* Foramen ovale.

at the root of the great wing of the sphenoid, close to its junction with the external pterygoid plate. It lies immediately behind and external to this process, and is on a level with the eminentia articularis of the temporo-maxillary joint, being placed at a depth of about 1½-2 inches from the surface of the face. (Fig. 12, F.O.) The long axis of the foramen is directed backward and outward, and its outer margin is only separated by a narrow neck of bone from the foramen spinosum which lies at the base of the sphenoidal spine, and through which the middle meningeal artery passes. It will be seen therefore that the foramen ovale lies midway between the base of the external pterygoid plate and the spine of the sphenoid, being covered by the origin of the external pterygoid muscle. The internal maxillary artery is superficial to both pterygoid muscles in the majority of instances, lying between the external pterygoid and the jaw, and passing into the spheno-maxillary fossa through its two heads. Occasionally the vessel passes between the two muscles, and thence to the fossa. This point should be kept in view in any operation upon these parts, as the early ligature of the vessel is most desirable. There is also a large plexus of veins in this region, from which troublesome hæmorrhage is sure to arise. But, however variable the vascular distribution, the dental and gustatory nerves are quite regular in the position which has been already described; emerging from beneath the external pterygoid muscle, they lie upon and are superficial to the internal. To expose these nerves in some way or other must be the first aim of the surgeon, and this done they can be traced to the base of the skull with comparative ease, and there divided.

Three different plans have been suggested and practised for reaching the foramen ovale:—viz., (*α*) Pancoast's method, with various modifications as suggested by Salzer, Krönlein, &c; (*β*) the Lücke-Sonnenburg method, and (*γ*) the plan of deepening the sigmoid notch as practised by Mr. Horsley, myself, and others.

(*α*) *Pancoast* was the pioneer in this department of surgery, and his first operation was performed nearly 20 years ago. It appears that only one case was treated

in this way, but the operation was an important step, and is justly deserving of record, in that it has served as a basis upon which many modifications have since been grafted. He dissected up a rectangular flap composed of skin and masseter muscle with its base at the zygoma, and exposed by this means the temporal tendon which was then detached from the coronoid process. This process was next removed by cutting-pliers close to the ramus of the jaw, and the pterygo-maxillary fossa opened up. The attachment of the external pterygoid muscle was then divided, the internal maxillary artery having been, if possible, previously tied. The third division of the trigeminal could thus be reached as it emerged from the foramen ovale. The operator must, however, have been considerably cramped in his manipulations, as the zygoma was left intact. Its removal or temporary displacement was soon added as an additional step in the operation. Again, the incision was devised irrespective of the distribution of the facial nerve, and the integrity of the duct of Stenson must have been seriously threatened. Of necessity the resulting cicatrix was extremely unsightly.

Salzer operated through a curved incision, having its convexity upwards; it extended from just in front of the tragus to a point above the zygoma, and terminated anteriorly at the lower border of the malar bone. This incision passed directly to the bone, and the zygoma was divided by the saw anteriorly at its attachment to the malar, and posteriorly in a line with the eminentia articularis. The temporal muscle was divided by a transverse incision across its fibres a little above the zygomatic arch, and the whole flap of soft tissues, including the loose piece of bone, was drawn down by scraping away with a raspatory the lower fibres of attachment of the temporal muscle to the squamous bone, until the pterygoid ridge of the great wing of the sphenoid was reached. Still keeping close to the bone, by detaching the external pterygoid muscle access was gained to the foramen ovale; this was much facilitated by opening the mouth, as by this means the coronoid process was depressed, and kept out of the way. In this procedure the operator has to

work down on the nerve from above, and his manipulations are much hampered by the limited space at his disposal. Necrosis of the zygoma has moreover resulted, but by taking suitable precautions this can be prevented. If it does occur it will always leave an unsightly cicatrix.

Another modification of Pancoast's original plan is that devised by Krönlein (*a*) in order to reach and divide both the second and third divisions of the nerve at the base of the skull. This method with the exception of the skin incision is practically identical with the preliminary steps of my present operation for removing the Gasserian ganglion, which will be described in my next lecture. In brief, it consists in dividing the zygoma in front and behind, and turning it down with the masseter after releasing it from the temporal fascia; and in dividing the coronoid process with the chisel and turning it up together with the temporal tendon. The external pterygoid muscle is then detached from the skull and the foramen ovale exposed. The foramen rotundum is reached afterwards through the pterygo-maxillary fissure, somewhat according to Lücke's method already described. The same objection applies to this as to the former operation in that it is an unnecessarily severe proceeding when the third division alone is to be dealt with; a similar result can be obtained by the simpler operation of deepening the sigmoid notch. But if it be requisite to divide the second division simultaneously with the third, then this plan may be advantageously employed. Such a step, however, will be rendered unnecessary if the Gasserian ganglion can be safely reached and dealt with.

(*β*) The foramen ovale has also been reached by the Lücke-Sonnenburg or retro-maxillary operation. Ullman (*b*) has recently recorded two cases treated in this way, and speaks most highly of it, inasmuch as the bones of the face are not interfered with except that it is occasionally necessary to divide the angle of the jaw and turn it temporarily outwards, replacing and wiring it sub-

(*a*) *Deutsche Zeitschritt fur Chirurg.*, xx, p. 484.

(*b*) *Wiener Klin. Wochenschritt*, June 20th, 1889.

sequently (as suggested by Albert); the superficial nerves divided are of no importance, the scar is placed well out of view, and the subsequent movements of the jaw are less likely to be impaired.

Mikulicz and Obalinski have proposed to reach the foramen ovale in a somewhat similar way The former makes an incision from the mastoid process along the anterior border of the sterno-mastoid to the level of the hyoid bone, and then upward and forward to the border of the jaw. The skin is now dissected up, and the bone carefully stripped of its periosteum is divided by a chain saw behind the wisdom tooth, great care being taken not to open the mouth cavity. The internal pterygoid muscle is next to be detached, and the vertical ramus can then be drawn well outwards leaving a funnel-shaped opening with its apex at the base of the skull in which the nerves are readily found and traced to the foramen.

(γ) The third method and that which I consider the best, not only for reaching the foramen ovale, but also for removing the largest extent of these trunks is that of *deepening the sigmoid notch*, a proceeding modified by Mr. Victor Horsley from Velpeau's original method of trephining the jaw. The following description of the way in which I now perform this operation is similar to Mr. Horsley's with a few exceptions, and, indeed, this method was originally suggested to me by him.

The skin is first rendered perfectly pure by previous washing with 1-20 carbolic lotion, and any hair or down removed, the razor being carried for a short distance into the temporal region. The auditory meatus and external ear are purified thoroughly, and the former plugged with a piece of salicylic wool or cyanide gauze. The skin incision is so planned as to leave a scar as unobtrusive as possible. Commencing about the middle of the zygoma, the knife is carried backward and downward over the parotid region to the angle of the jaw, and then for a short distance along the horizontal ramus (Fig. 9, *c*). A semilunar flap consisting of skin and subcutaneous tissue only should be raised and turned forward, and for convenience temporarily stitched across the opposite

side and carefully protected. This flap must be so dissected as not to injure any of the branches of the facial nerve. By this means are exposed the masseteric fascia, the branches of the facial nerve, Stenson's duct, and a portion of the parotid gland. The deep fascia and masseter muscle are then divided by a transverse incision below and parallel to Stenson's duct, cutting directly down to the bone about a centimetre below the sigmoid notch. Great care must be taken not to wound any of the lobules of the parotid whilst so doing, for even though the main duct be not divided a salivary fistula may ensue, leading to interference with the healing of the wound. The outer surface of the jaw is next denuded of periosteum by means of raspatories, and the soft parts held aside by suitable retractors to allow of the application of a trephine, the diameter of which should not be less than $\frac{3}{4}$ in. It should be so applied as to leave between it and the sigmoid notch a narrow bridge of bone which can be sub-

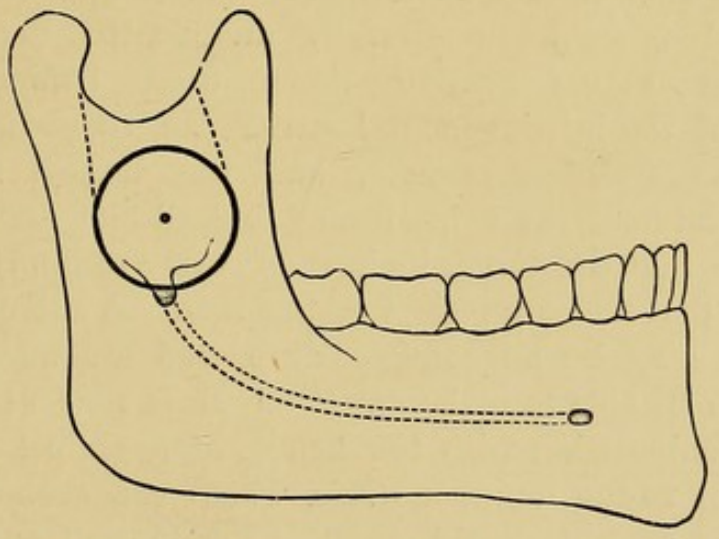

FIG. 13.—Side view of lower jaw, showing position of trephine opening in the operation for deepening the sigmoid notch. The two upper dotted lines indicate the extent of the bridge of bone, which also needs removal.

sequently clipped away by cutting pliers, and a sufficient amount of bone in front and behind to preserve the continuity of the jaw with the articular and coronoid processes. (Fig. 13.) At this stage the inferior dental artery may be cut through by the trephine and give

rise to troublesome hæmorrhage. The disc of bone having been lifted out and the bridge of bone between the condyle and coronoid process clipped through with bone pliers so as to increase the space in which to work, some loose fatty tissue presents and should be carefully picked away with two pairs of dissecting forceps. The tendon of the temporal muscle is thus more clearly defined, and must be held forward, if necessary. Narrow spatulæ are useful at this stage, not only to keep the wound open, but also by their pressure to arrest hæmorrhage from divided muscular branches. If the bleeding is troublesome the wound should be packed for a few moments with small pieces of sponge wrung out of hot 1-40 carbolic lotion, any obvious bleeding point being secured by ligature. The inferior dental artery, if still intact, is usually first seen and may be secured by passing two ligatures around it with an aneurism needle and dividing it between. The lowest fibres of the external pterygoid muscle are seen running transversely across the wound and require to be held upward or carefully divided, to demonsrate the two nerves passing down from behind. The trunk of the inferior dental nerve can then be raised upon an aneurism needle, and the lingual found a little internal and in front; indeed it occasionally happens that the nerves lie in such close proximity to one another that they are picked up together. A silk or catgut ligature may be advantageously passed around them in order to be able to make traction. It is now easy by a little manipulation with the handle of a scalpel to trace them up to the foramen ovale, which can even be seen, if the external pterygoid muscle be held well out of the way. The nerves can then be divided close to the skull either by scissors or knife, and the meningeal artery should be in no danger if the nerves have been sufficiently isolated. Peripheral traction is also employed so as to draw up as much of the nerve as is possible, and thus a considerable portion—more than an inch—of the trunks can be readily removed. All bleeding having been arrested, the wound is irrigated with some 1-40 carbolic lotion, and the skin flap neatly

brought together with a continuous suture. There is no need to insert a drainage tube, and as a rule healing by first intention is readily obtained. I have performed this operation repeatedly during the last seven or eight years, and always with relief to the patient for the time being; but I must also confess that in by far the majority of cases the pain has recurred at the end of a year or two, necessitating those further measures which I shall detail in my next lecture.

LECTURE III.

The Gasserian Ganglion (*a*) and its Removal.

MR. PRESIDENT AND GENTLEMEN—

IN my previous lectures I have traced the history and gradual development of the surgical treatment of Trigeminal Neuralgia, showing clearly the tendency amongst surgeons in this and other countries to substitute more central and radical measures in the place of less effectual peripheral treatment. For, however great the relief may be for a time after neurectomy, or combined neurectomy and nerve-stretching, a recurrence of the painful symptoms is unfortunately the rule rather than the exception. In a few months or perhaps at the end of a year, these patients apply for further treatment, and in many instances are willing to undergo any risk from an operation that holds out the slightest prospect of alleviating their sufferings. They have told me that life under such circumstances is unendurable, and have even threatened self-destruction when the paroxysms have been extremely severe, reason itself being endangered; whilst others have expressed the hope that they might never regain consciousness from the anæsthetic administered at the operation, rather than again experience such exquisite agony. It was a case of this desperate character that first stimulated me to make an attempt to reach and remove the Gasserian

(*a*) The term "Casserian" has also been applied to this ganglion, but incorrectly so, as it is named after Johann Laurentius Gasser, an anatomist of the 18th. century, of whom nothing is known save that he was the instructor of Antonius Raymond Balthasar Hirsch, who in 1765 named the ganglion after his teacher. (New Sydenham Society's *Lexicon of Medicine*, 1888.)

ganglion; and after conversations with Dr. Ferrier and Mr. Horsley, and a careful study of the anatomical relations of the ganglion to the base of the skull, I was convinced not only of the possibility, but also of the practicability of this proceeding. The results more or less favourable following the removal of Meckel's ganglion also acted as a powerful argument in favour of producing a still more satisfactory effect if the Gasserian could be reached and isolated from the brain, even if the whole ganglionic mass could not be excised.

Surgical Anatomy.—The *Gasserian or Semilunar Ganglion* is a small mass of greyish-yellow nerve substance, analogous to the ganglia upon the posterior roots of the spinal nerves, as it forms an expansion upon the larger or sensory root of the trigeminal nerve, the motor root being separate. The trunk of the fifth nerve issues from the pons as a cord flattened horizontally, and passes through an opening in the dura mater to reach the apex of the petrous portion of the temporal bone where the ganglion is lodged. This opening is placed immediately behind the posterior clinoid process in the substance of the anterior attachment of the tentorium, and has the superior and inferior petrosal sinuses respectively above and below it. The space in which the ganglion is located is known as the Cavum Meckelii, and corresponds exactly to the depression at the apex of the petrous bone. It is essentially an extra-dural space, a matter of considerable importance in any operative interference. Some French anatomists, however, state that the space is lined below by a thin reflection of the dura mater, and thus the ganglion really lies encapsuled within the dura. In shape the ganglion is crescentic, or somewhat like a haricot bean flattened out, with the convexity forwards. The antero-external surface is in somewhat close relation with the dura mater, from which it is not easily separated; the postero-internal surface lies on the bone, a thin layer of dura, acting as periosteum, intervening, and with this it is very loosely connected. The trunk of the fifth nerve enters its postero-superior border at a point corresponding to the hilum, and at the antero-

inferior border are given off the three main divisions. (Fig. 14.) The anterior portion is prolonged into the ophthalmic division, which is very closely connected with the dura mater forming the outer wall of the cavernous sinus, and it is a question whether the removal of this portion is possible without laceration of the sinus.

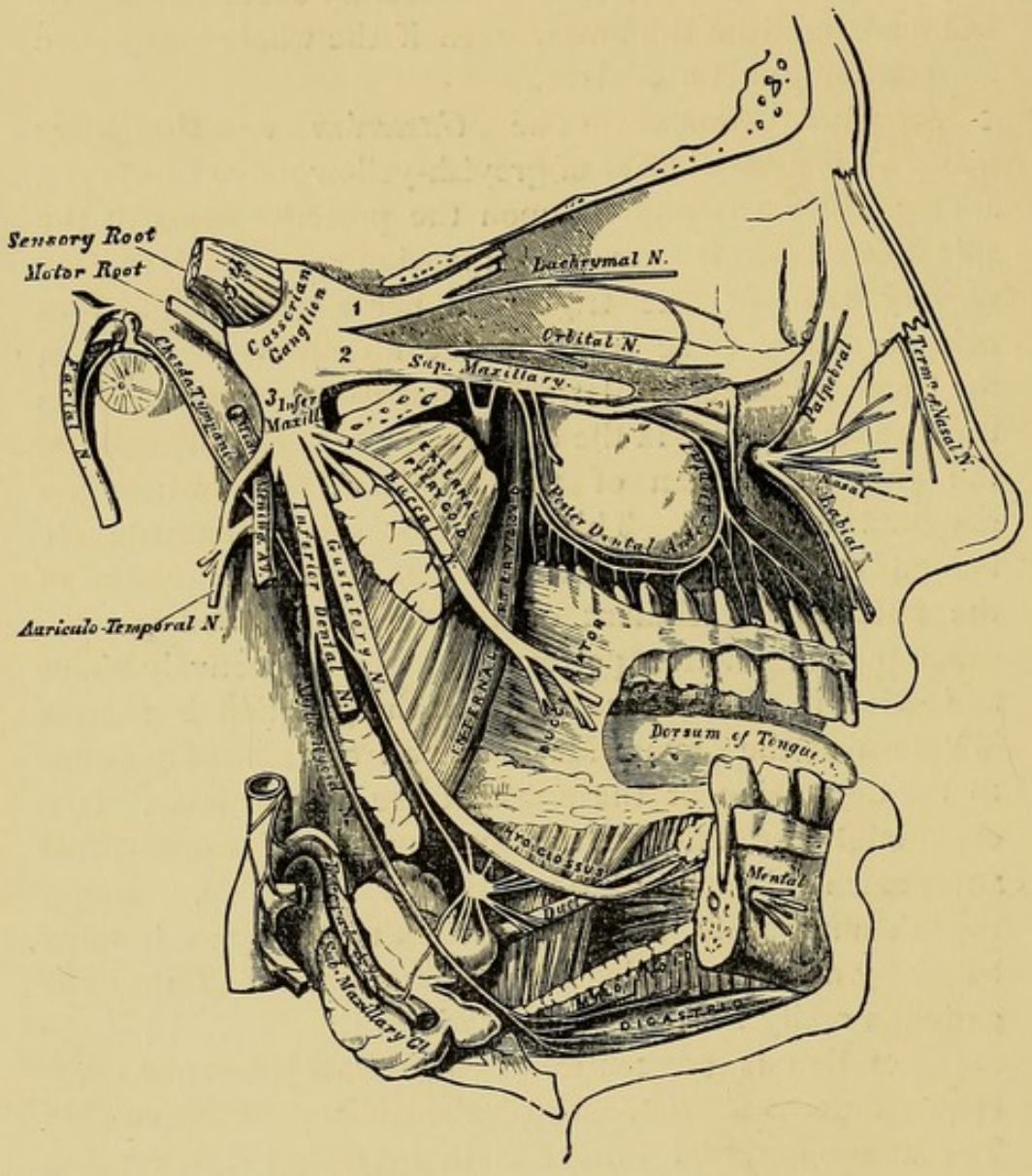

FIG 14.—Gasserian ganglion and its branches. (*Longmans & Co.*)

Thiersch and Horsley both emphatically contend that the detachment of this portion is impossible; but recent investigations have convinced me that on the cadaver at least it can be accomplished, though not without some difficulty.

The internal carotid artery passing upward in its canal in the petrous bone lies first below and then internal to the ganglion, previous to gaining its position by the side of the posterior clinoid process in the floor of the cavernous sinus.

Operative Treatment.—The various methods which have been suggested and practised of reaching the ganglion must now be considered. Up to the present this has been accomplished, in three different ways, viz.:—

(1.) By Mr. Horsley's intracranial operation.

(2.) By ablation of the superior maxilla, and trephining the base of the skull; and

(3.) By trephining the base of the skull through the pterygoid region; this method which is an elaboration of Krönlein's (*a*) modification of Pancoast's original proceeding, I have adopted in my last four cases.

I have recently received an interesting communication from Professor Andrews of Chicago (*b*), who during the last twelve months has been making investigations on the cadaver as to the best means of reaching the ganglion. He has also sent me details of two cases in which he has followed out my suggestions in his operation, and to which I shall presently refer. His studies have led him to much the same conclusions as to the best and most direct means of effecting this. He suggests six different routes; but, inasmuch as two of them are essentially very slight modifications of my own plan, they may, for practical purposes, be reduced to four, the three mentioned above, and a fourth which, however, is only suggested as possible on the cadaver, and is at once condemned by the author himself.

I. With regard to the *intracranial operation*, Mr. Horsley has so recently published his views on this subject (*c*), and his method of operating, that a detailed description here will be unnecessary; briefly, it consists in the exposure of the squamous portion of the temporal bone by turning

(*a*) *Deut. Zeitschritt f. Chirurg.*, xx., p. 484.

(*b*) Papers read in Section of Surgery and Anatomy at Amer. Surg. Ass., 1891, p. 153.

(*c*) *British Medical Journal*, December 5th, 1891.

down a large temporal flap and in the removal of the whole of the exposed bone by means of a trephine and bone forceps. The dura is then freely divided along the whole length of this opening, and the temporo-sphenoidal lobe laid bare. "A broad copper retractor with smooth and everted edges is then gently slipped underneath the lobe, and slowly but steadily raised. The lobe is partly moulded, partly lifted upward, and the floor of the skull is then seen and illuminated by the electric light." The edge of the tentorium is looked for, and the position of the root of the nerve, as it emerges from the brain, ascertained. The ganglion will not be visible at present, being covered by the dura, but an incision is made at the point where he considers it should be, and by enlarging this the nerve root is stated to be seen with ease, "freely lying in the little canal," to use his own words, and can then be divided and the ganglion removed. The first case Mr. Horsley treated in this way proved fatal in seven hours from shock, and as far as I can make out from the information given in his table of results he had not, when his paper was written, attempted a similar operation again, though in two cases an intra-cranial division of the nerves was undertaken, the exact details of which are not stated, but in neither of these was the ganglion dealt with.

An examination of the inside of the base of the skull from which the brain has been recently removed is sufficient to convince one of the difficulties which must be experienced in attacking the ganglion from above; much more so is this the case with the brain *in situ*. Again, when we consider that the ganglion is situated practically outside the dura mater, it seems an unnecessary increase in the severity of the operation to open this investment in two different situations; and, however delicately we may handle the temporo-sphenoidal lobe, it can do it no good to compress and mould it by retractors to a sufficient extent to enable the base of the skull to be clearly seen, and the necessary manipulations undertaken, all of which entail a considerable degree of shock. Moreover, Mr. Horsley himself admits that several small veins passing from the temporo-sphenoidal lobe to the

superior petrosal sinus must be torn in this proceeding, and so give rise to troublesome hæmorrhage, and the superior petrosal sinus itself will hardly escape, if an incision be made through the dura in the direction indicated. Bleeding in this locality is difficult to arrest, and even if not absolutely dangerous to the patient from its extent, it may become so by its pressure effects. Again, the extensive removal of cranial bone must be a source of subsequent risk to the patient, and the disfigurement of the face from the large temporal flap is very marked. These latter points however would be of little importance if certain relief could be given to the painful condition without danger to life. From these considerations one cannot resist the conclusion that this method of reaching the ganglion is scarcely justifiable in the light of present experience, and that if it can be satisfactorily dealt with along some safer route it is far better to avoid the risks certainly associated with such an extensive intracranial operation.

II. My own efforts hitherto have been entirely directed to reaching the ganglion through the base of the skull, and at present, after an experience of five cases, I see no reason for altering my views. In the first case one condition on which I was allowed to operate was, that I should remove what was thought by the patient to be the seat of greatest pain, viz., the right superior maxilla; under no other circumstances should I have undertaken such a disfiguring plan of treatment. The operation of *ablation of the superior maxilla* was performed in the usual way without any difficulty, and as generally happens, the pterygoid processes were broken off close to their base. This gave me plenty of room to expose the foramen ovale, and the trephine was easily applied in a direction upward and a little backward. After the removal of the disc of bone containing the foramen as its centre, the ganglion could be easily seen both by myself and my assistants by the aid of the electric illuminator, without which manipulations at such a depth would be impossible. At that time I was not provided with the special hooks I have used in my later cases, and so I picked the ganglion away piecemeal

with a pair of fine hooked forceps. As the wound communicated with the mouth, its asepticity could not be maintained. This condition may account in part for the loss of the eye, but with this exception the patient made an excellent recovery. I regret that I did not take proper precautions to render the conjunctival sac aseptic before the operation, or to protect the eye subsequently. It is possible, moreover, that a drop or two of chloroform may have fallen into and irritated it, as the patient was somewhat restless. Be that as it may, subsequent experience would tend to prove that, unless the strictest precautions be taken for the protection of the eye at the time of the operation and for weeks after, the disturbance of the trophic centres may lead to degenerative changes entailing the loss of the organ. But even if the eye should unfortunately be lost, the immunity from pain more than compensates for this.

III. My present operation *through the pterygoid region*, must be described in detail.

Preparation of Patient.—The patient should be in as favorable a condition as possible. The bowels are moved by a mild purgative given the night before. The face is washed as thoroughly as the patient will permit with soap and carbolic solution (1-20) some hours before, and an antiseptic dressing applied. This is important seeing that (as I have previously remarked) the skin is often very dirty on account of the pain caused by any attempts at washing. Chloroform is, perhaps, the most convenient anæsthetic to employ, and when the patient is fully under its influence, the skin and external ear should be again thoroughly cleansed, and a plug of salicylic or some antiseptic wool inserted into the meatus. The conjunctival sac must also be thoroughly washed out with an efficient but unirritating antiseptic, a 1-2000 solution of corrosive sublimate being, perhaps, the most satisfactory; during this proceeding, the lachrymal sac should be squeezed, as collections of mucus are often found therein, and regurgitation of these through the canaliculi may cause septic contamination of the conjunctiva. In order to ensure closure and protection of the

eye, both during the operation and for some days after, two fine horsehair or catgut sutures are introduced through the integument of the upper and lower lids about 2 mms. from the palpebral margin of either lid, and exactly opposite each other, taking up small folds of the lax skin, which are approximated by tying the sutures.

The operation itself may be divided into six stages, as follows :—

1. Incision through skin and reflection of flap.
2. Section of zygoma and coronoid processes, and detachment of masseter and temporal muscles.
3. Exposure of the base of the skull, and search for the foramen ovale.
4. Opening the base of the skull.
5. Removal of ganglion.
6. Reposition of displaced structures, and closure of wound.

Stage I.

The skin incision (Fig. 9, *c*) is made by entering the knife over the malar bone about half-an-inch below the external angular process of the frontal, and carrying it along the zygoma, and down in front of the ear over the parotid region to the angle of the jaw, and then forward along the lower border of the horizontal ramus as far as the facial artery. This done, a flap can now be dissected forward, consisting of skin and subcutaneous fat only, care being taken not to injure Stenson's duct or any of the branches of the facial nerve which lie in close contiguity to the masseteric fascia. Before this is completed, either a fine catgut thread can be inserted in either side to form a land-mark in the subsequent suturing of the wound, or a cross-cut can be made in the skin. The scar resulting from this incision can be rendered almost imperceptible if great care be taken in stitching the parts together and accurately matching them up.

Many other incisions have been devised for similar operations in this neighbourhood, but they are not so satisfactory. Krönlein used an incision which was

practically H-shaped, the transverse piece being placed over the zygoma. Pancoast operated through vertical incisions placed along the anterior and posterior borders of the masseter muscle and joined by a transverse cut along the zygoma. The great objection to these is the anterior vertical incision, which is very disfiguring and of doubtful utility. It is perfectly feasible to dissect up a skin flap from the face without encroaching on the nerves, and I would contend that the curved incision, whilst it gives a maximum of space with a minimum of disfigurement, will in no way interfere with the subsequent mobility of the facial muscles.

The skin flap must be carefully protected by a few layers of purified gauze during the operation, and not unneccessarily handled, or exposed to pressure or rough manipulation. It is better to avoid retractors in order to hold it out of the way, and its temporary fixation by a catgut suture to the upper part of the chin will be found beneficial. The anæsthetist should prevent any chloroform dropping on the under surface of the flap, and not allow any part of his apparatus to touch it. Particular stress is laid upon these details, as it is most important not only to maintain asepsis and obtain primary union, but also to leave as little trace of the surgeon's work as possible. After raising the flap any arterial hæmorrhage of importance should be controlled by Spencer Wells' forceps, and probably the transverse facial vessels will need ligature.

Stage II.

Section of Zygoma and Coronoid Process, and Detachment of Masseter and Temporal Muscles.—The zygoma is now exposed by means of suitable raspatories and periosteum detachers through an incision along its course. Two holes are drilled at the root of the zygoma, and two also anteriorly through the zygomatic process of the malar bone. This is best accomplished by a fine drill driven by a dynamo. The drill used should be of

such a size that the perforation in the bone may carry wire of gauge No. 22, and the holes should be about one-third of an inch apart. The bone is then divided between them with a fine saw, and in such a way that the anterior saw-

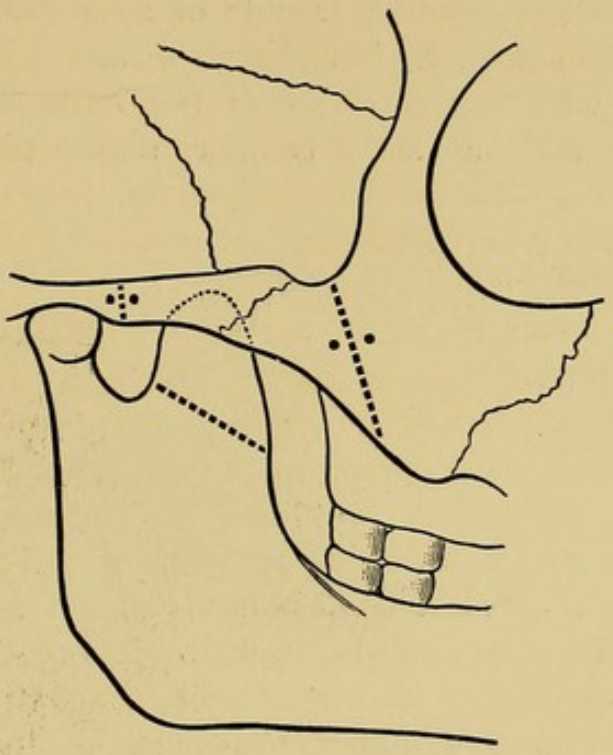

FIG. 15.—Diagram of zygoma and lower jaw *in situ*. The interrupted lines represent the direction of the saw cuts, and the dots on either side of those in the zygoma the drill holes.

cut is directed obliquely downward and forward, the posterior part of the zygoma being divided as near its root as possible (Fig. 15). It is obvious that the bone can be drilled much more efficiently whilst the zygomatic arch is intact, and can be subsequently replaced without difficulty, and maintained in position by means of silver wire.

The zygoma thus detached is displaced downward and backward together with the masseter; to facilitate this it will be necessary to completely divide the muscular fibres attached anteriorly to the malar bone. Necrosis of the zygoma has occurred in some instances where it has been detached and turned down by this plan of treatment; but such was probably due either to septic contamination of the wound, or to some rough handling of the bone which might have been avoided. The

attachment of the fibres of the masseter muscle to its under surface, from which its nutrition is derived, must not be interfered with; and in all probability the wiring of the bone into position after preliminary drilling is another preventive of necrosis, for in none of my own cases have I had the slightest trouble or subsequent difficulty. When the masseter has been sufficiently depressed consistent with the integrity of the important adjacent structures, and a little cellular tissue picked away,

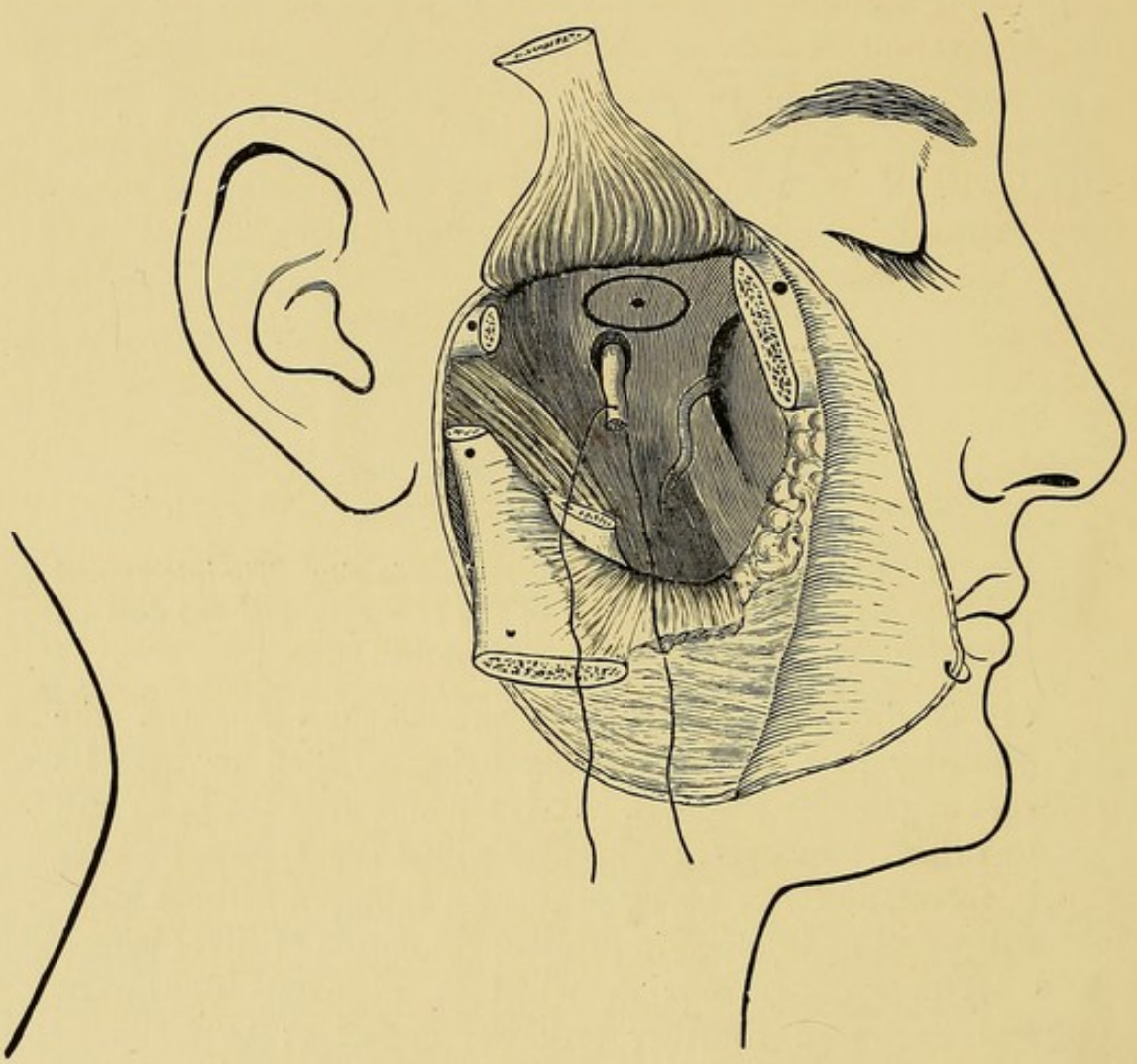

FIG. 16.—Sketch from dissected subject, showing stages of operation. The zygoma and masseter are turned downward and backward; the coronoid and temporal upward; the great wing of the sphenoid exposed by detachment of external pterygoid, showing relative position of foramen ovale and trephine track. (For clearness sake the two latter are purposely placed a little forward.)

the coronoid process will be exposed together with the tendon of the temporal muscle, which passes further down on the inner aspect of the bone than on the outer. In Cases II, III, and IV, this process was drilled to provide holes for subsequent wiring, and then divided obliquely downward and forward. (Fig. 15.) The detached bone was turned up with the temporal muscle, and the deep fibres encroaching upon the ramus of the jaw carefully divided. But latterly I have questioned very much the advisability of attempting to gain osseous union of this process; for the temporal muscle attached to it is paralysed by the operation, and necessarily atrophies, with the result that very considerable impairment of the mobility of the jaw ensues. In my last case therefore, I simply divided the coronoid without attempting to drill it, and drew it and the muscle upward out of the way, subsequently excising it and a portion of the tendon.

Stage III.

Search for the Foramen Ovale.—A certain amount of loose cellular tissue and fat will now present, under which will be found the external pterygoid muscle, running transversely backwards, to be inserted into the condyle of the jaw (Fig. 16), and perhaps below it a small portion of the internal pterygoid may be seen. Running superficially across the former muscle, between it and the jaw, the internal maxillary artery is usually found, passing into the spheno-maxillary fossa between the heads of the muscle. The artery, if it has not been tied at a previous operation, should now be sought for, and divided between a double ligature; by this means hæmorrhage, which might be troublesome during the later steps of the operation, will be avoided. The inferior dental and gustatory nerves under normal circumstances pass downwards from under the lower border of the external pterygoid muscle; but if they have been previously removed, their assistance in guiding the surgeon to the foramen ovale is not available. The external pterygoid muscle is next

detached from the great wing of the sphenoid and from the outer surface of the external pterygoid plate by scraping it from the bone with suitable raspatories from above downward. The knife should be used as sparingly as possible, and the strands of muscular tissue are best picked and cut away with dissecting forceps and a fine pair of blunt-pointed scissors. By this means the under surface of the great wing of the sphenoid is exposed, as well as the outer pterygoid plate.

The foramen ovale is now to be brought into view, a matter often of some difficulty, and the occasional reference to a dry skull held by an assistant will be a considerable help in indicating its position in relation to the neighbouring landmarks. It is usually on a level with the eminentia articularis, but occasionally lies a little behind it. In fact, the portion of bone which one first reaches in this deep part of the operation is well in front of the foramen, and one is apt to get too far forward, so that the pterygo-maxillary fissure is mistaken for it. In the third of my cases this actually occurred, and at first I trephined the sides of the fissure, not discovering my mistake until I found orbital fat protruding from the opening. The relation to the root of the pterygoid processes is another guide; the foramen lies usually a little behind and external to the base of the outer plate, but sometimes directly behind it. The position, however, is not constant, and Mr. Carless has found the greatest variety in the skulls which he has examined for me. The base of the external pterygoid plate, he states, is by no means a fixed guide, in that in many old skulls there is a formation of bone (like a tongue) projecting backwards towards the spine of the sphenoid, usually *external* to the foramen ovale, and deeply channelled or grooved for the middle meningeal artery. M. Testût (*a*) also mentions this fact, stating that it is due to an ossification of the pterygo-spinous ligament of Civinini. The sphenoidal spine lies immediately behind the foramen ovale and about a centimetre from it, the foramen spinosum intervening and placed about two millimetres behind the oval opening;

(*a*) Testût, "*Traité d'Anatomie Humaine*," 1889, Vol. I, p. 113.

the spine cannot, however, always be felt on the living subject on account of the depth of the wound and the limited space in which one is working. Under these circumstances, it is important to define clearly with the finger the outer pterygoid plate, and help may be obtained from the facts ascertained by the measurement of a number of skulls by my colleague, that in an adult male skull the average distance from the anterior border of the outer pterygoid plate (*i.e.*, from the posterior lip of the pterygo-maxillary fissure) to the centre of the foramen ovale is about 18 mms., whilst in the female adult skull it is about 16·5 mms.; in both sexes, the average measurements are a little greater on the right side; but in skulls that are abnormally large or small, they vary to a corresponding degree. Should the above-mentioned pterygo-spinous ridge of bone be met with it may be necessary to clip it carefully away, in order to define the position of the foramen.

Stage IV.

Opening the Base of the Skull.—Having exposed the foramen ovale and traced to it either the trunk of the undivided lingual and dental nerves, or the stump left from former operations, the base of the skull is now to be opened by means of the trephine. My intention in cases II, III, and IV, was to remove a disc of bone having the foramen ovale for its centre, and for this purpose I employed a trephine with a handle set on a stem long enough to clear the cheek, and with a reversible centre-pin, one end of which was pointed as usual, the other blunt. The size of the trephine was such that it should remove a ½-inch disc of bone; the crown was serrated obliquely on the outer side for a distance of a quarter of an inch in order that the trephine might clear itself of *débris*, and not get jammed in the bone. This trephine is similar to one used by Mr. Horsley, with the exception of the reversible centre-pin.

The smooth-ended centre-pin was projected as

far as possible, and passed into the foramen ovale, so that the blunt point might protect the dura mater or other intra-cranial structures by pushing them before it. To do so, the trephine was roughly speaking held in such a position that its axis was parallel to the external pterygoid plate. The handle of the trephine was then depressed and kept as far back as possible; but from the pressure of the soft parts it was always applied at an angle, and not perpendicular to the surface, a proceeding not altogether undesirable, inasmuch as thereby the integrity of the carotid canal could be more readily maintained. The close contiguity of this structure had to be carefully kept in view during this stage of the operation, and, indeed, there is only the inner border of the great wing of the sphenoid, measuring from 2 to 4 mms. in thickness, intervening between it and the foramen ovale. By holding the trephine at this angle, the outer segment of the bony circle was cut through first; the bone could then be broken off on the inner side along the sutural line between the apex of the petrous bone and the great wing of the sphenoid, and thus the carotid canal remained uninjured. But even if it should be encroached upon, it by no means follows that the artery lying within will be damaged, as there is always a certain amount of space to allow of its expansion and other movements under the blood pressure. The disc of bone being now set free by an elevator, will fit like a collar over the stump of the divided nerve, and can be slipped over it. In one or two of my cases I noticed a definite constriction of the nerve at this point,

In Case IV, I made an important modification by trephining in addition the great wing of the sphenoid anterior and a little external to the foramen. The trephine openings were then united by removing the intervening bridge of bone by a careful use of chisel and mallet. During this process the dura mater, which had been previously loosened around the openings, was protected by a copper spatula, and held up out of the way, for when unsupported it bulged through the opening. As will be seen by reference to the account of my cases which I append,

this patient did well, but during the first 48 hours after the operation she had a certain amount of epistaxis and also vomited some grumous material, like coffee grounds, which was evidently altered blood. The source

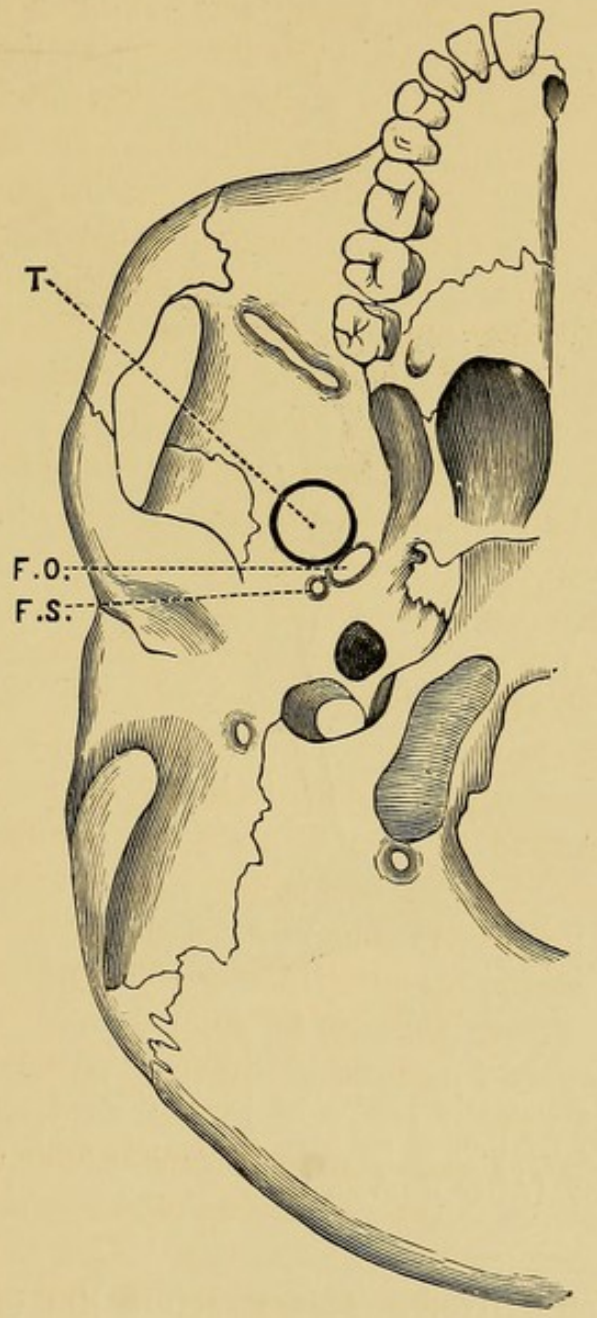

FIG. 17.—Diagram of base of skull, showing position of trephine track.

T., Trephine track. | F.O., Foramen ovale.
F.S., Foramen spinosum.

of this was a matter of considerable anxiety to me; it evidently did not come from either the sphenoidal sinus or the antrum, as these were in no way interfered with, but on careful examination of the base of a skull the relationship of the Eustachian tube, which had been previously overlooked, seemed clearly to indicate whence the

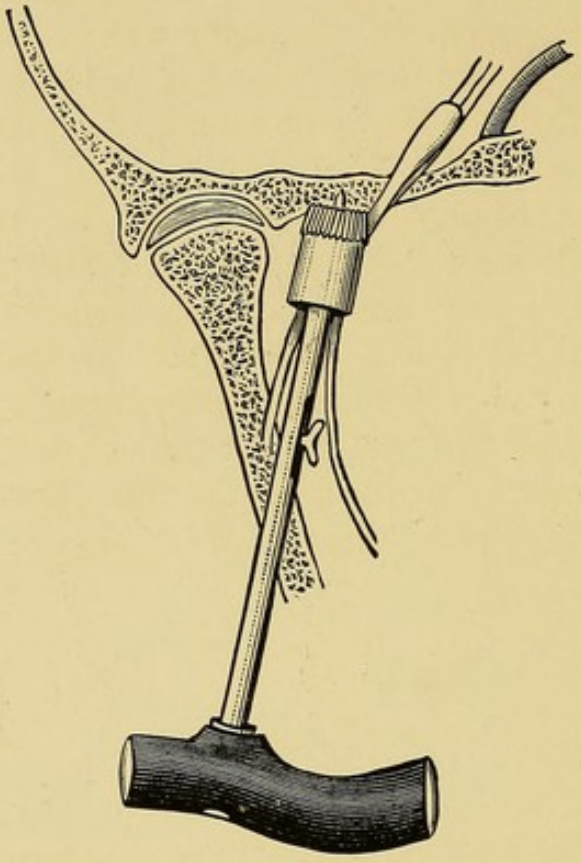

FIG. 18.—Diagrammatic section of base of skull and lower jaw showing relation of trephine to foramen ovale and Gasserian ganglion. (After *Andrews*.)

bleeding was derived. This structure lies in immediate contiguity to the ridge of bone which forms the inner boundary both of the foramen ovale and spinosum. A groove will be found in this position in most skulls extending backward to the point of attachment of the tube to the petrous portion of the temporal bone and

forward to the base of the pterygoid process; and this depression is occupied by the cartilaginous portion of the tube. It is highly probable that in removing a disc of bone, half an inch in diameter, with the foramen ovale as its centre, this structure will be encroached upon, laying the wound open to the risk of septic contamination from the pharynx. This consideration was one of several, which induced me to alter my plan of operation in the last case I dealt with; I applied the trephine to the great wing of the sphenoid a little anterior and external to the foramen, and in such a way that the circumference of the disc just impinged on its outer wall. (Figs. 17 and 18.) The opening thus made can be subsequently enlarged, if necessary, in any direction desirable. It must not be forgotten that the thickness of the skull is very unequal, being thinner on the outer margin of the trephine track than on the inner; and inasmuch as the instrument is necessarily applied at an angle, the outer half will be cut through before the inner. This fact renders damage to the dura possible in spite of the most careful precautions.

Stage V.

Removal of the Ganglion.—Having repressed the prominent dura with a spatula, the trunk of the third division which during all these preliminary proceedings has been carefully guarded, and round which a ligature should now be passed, is to be traced up to the ganglion, which should be loosened from its resting place upon the apex of the petrous portion of the temporal bone. No great difficulty need be experienced as regards the posterior half, but inasmuch as the anterior and upper portion is closely incorporated with the dural sheath, it is perhaps better to sever the connection between the ganglion and the brain at its exit from the dura, and then to draw it forward with a delicate pair of forceps. For this work a pair of fine hooks such as those made

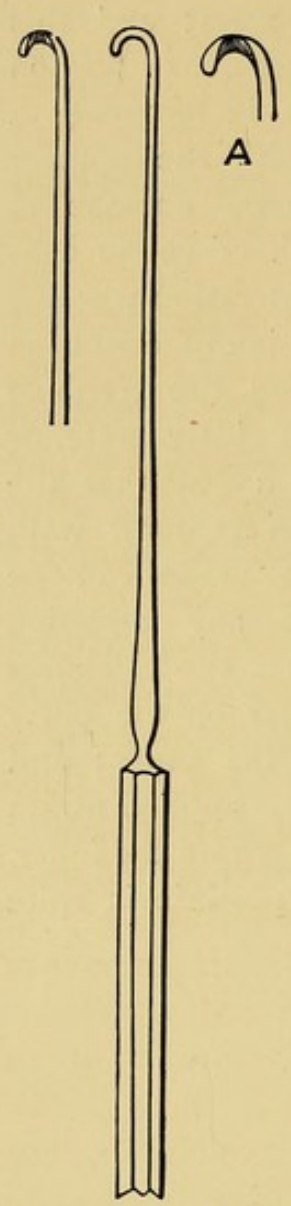

FIG. 19.—Hooks for dealing with the ganglion (actual size). A. Enlarged sketch of hook, to show concave cutting edge.

for me by Mr. Hawksley (Fig. 19) will be found most useful; one of them is an ordinary blunt-pointed hook to pass round the nerves and free them from their connections; the other has a sharp edge upon its concave aspect to be used for cutting them through. A pair of long-handled strabismus scissors may also be required. It is quite possible that in dividing the root of the nerve just outside the dura a prolongation of the subdural space may be opened, and a small quantity of cerebro-spinal fluid escape through it; this, however, will be of slight extent, and is of no moment, if the wound be kept aseptic. The second division of the nerve must now be dealt with, and this may be facilitated by enlarging the opening in the base of the skull in the direction of the pterygoid processes, and holding up the dural wall out of the way; it may be divided just in front of the ganglion by the sharp hook. Having thus severed all its connections except the ophthalmic division, the ganglionic tissue, which is exceedingly soft, may be pulled away piecemeal by forceps or by a small curette as recommended by Professor Andrews. In this way the danger of wounding the cavernous sinus is reduced to a minimum.

STAGE VI.

Reposition of Displaced Structures and Closure of Wound.—After the steps detailed above have been satisfactorily accomplished, the toilette of the wound must be attended to. The bleeding having been staunched, the parts should be thoroughly washed with a warm 1-40 solution of carbolic acid.

The coronoid process may be either sutured or removed; in my last case I removed it. Silver wire should be passed through the holes previously drilled in the zygoma, so that it can be accurately adjusted. By this means the contour of the face will not be interfered with, the chances of necrosis or collapse of the zygoma prevented, and firm bony union assured. The integuments may now be brought together with a continuous fine catgut suture, care being taken to adapt the parts accurately to each other. No drain tube is needed, although in my first two cases I used one as a precautionary measure. If the wound has been occasionally irrigated during the operation, and complete asepsis maintained, primary union may certainly be expected. I am glad to say that no suppuration has occurred in any of my cases. To prevent accumulation of blood in the wound, gentle but continuous pressure by means of a purified sponge introduced between the second and third layers of the cyanide gauze will be found very efficacious for the first forty-eight hours. In addition to the face dressing, both eyes should be carefully covered with pads of salicylic wool and lightly bandaged. A certain amount of shock necessarily follows such a protracted operation, and a subsequent elevation of temperature must be expected at the end of the second day. Beyond this no symptoms of importance have been exhibited. The dressing has usually required changing once or twice in the first four days, at the expiration of which time it may be replaced by gauze fixed down with collodion. The stitches can be removed at the end of a week, if they have not already been absorbed. The eye should be kept closed for at least four days when the stitch in the lids may be removed; but it is safer to keep both eyes bandaged for a week, and the eye on the side operated on for three or four weeks.

I now append a brief *résumé* of my cases:—

CASE I.—Mrs. F. M., aet. 60, sent to me by Dr. Padman of Bloomsbury, first came under my care in 1888. She had been suffering for five years from severe neuralgia, which had specially affected the inferior dental nerve of the right

side. Counter-irritation and constitutional treatment having failed, the dental nerve was stretched at the entrance to its canal through the mouth on August 19, 1888, and at the same time was divided at its exit from the mental foramen. This was followed by relief until March, 1889, when the pain returned with great severity, for which the lower jaw was trephined and half an inch of the nerve excised. Partial relief followed for a year; but in March, 1890, the lingual and dental nerves were cut down upon by deepening the sigmoid notch, and divided close to the base of the skull. The pain now recurred in the second division with greater intensity than before, any touch upon the upper jaw of that side producing a shock of agony terrible to witness. On April 2, 1890, I performed ablation of the superior maxilla, and trephined around the foramen ovale for removal of the ganglion (p. 61). The patient made an excellent recovery with the exception of the ocular trouble already alluded to. The latest report dated January 28th, 1892, states that she is still quite free from pain, and her general health very good.

CASE II.—Mrs. S. C., æt. 63. The neuralgia had commenced ten years before she came under observation, in connection with the teeth of the right lower jaw, and in spite of all treatment it spread to other branches and increased in severity. In 1884 all the teeth on the right side both of the upper and lower jaws were extracted, but without any relief. Drugs and local applications had no effect. When first seen by Dr. Ferrier and myself, the case was typical, a paroxysm being elicited by almost any movement of the jaw or stimulus from without, the pain chiefly affecting the lingual and dental nerves, and the back of the orbit, and shooting down into the palate. In consequence of the evident implication of the second as well as the third division of the trigeminal, Dr. Ferrier recommended that the Gasserian ganglion should be dealt with at once, without having recourse to any minor measures. As I entirely agreed with this opinion, the operation was undertaken on Jan. 29, 1891. The foramen ovale having been exposed through the pterygoid region was trephined, and the opening increased by a larger trephine. The ganglion was then removed piecemeal. The patient made an uninterrupted recovery. The cornea was anæsthetic when exposed four days after the operation, and the conjunctival reflex was diminished for some time, but no trophic disturbance manifested itself. Slight difficulty in mastication was subsequently experienced, but this soon passed off. There has been no recurrence of the neuralgic pain, and the

patient was seen by me only a few days ago (*i.e.*, about the end of January, 1892).

CASE III.—Mrs. E. K., æt. 63. The neuralgia in this patient had lasted for about five years, having originated in the inferior dental nerve as the result of carious teeth, which were removed, but without benefit. In February, 1890, I divided the inferior dental and gustatory nerves close to the foramen ovale by deepening the sigmoid notch, and excised about half an inch of each. This was followed by relief for about a year, when she was re-admitted to the hospital with pain in the second and third divisions, but especially referable to the former. The operation for extirpation of the Gasserian ganglion was performed on Oct. 29, 1891, by the usual incision and with the usual precautions. The great wing of the sphenoid and external pterygoid plate having been cleared, what was considered to be the foramen ovale was exposed and the trephine applied; the appearance of some orbital fat, however, through the trephine hole indicated that the pterygo-maxillary fissure had been mistaken for it. The raspatory was again employed further back, and the foramen ovale clearly demonstrated. Owing to the previous operation there was less hæmorrhage than usual, but the tissues were much matted together and so interfered with the application of the trephine. The base of the skull was opened and as much of the ganglion as could be seen removed. The wound was treated as usual, and healed without trouble, both the coronoid process and zygoma being wired. For a time the right eye was painful and the conjunctiva congested with some œdema of the lids, but there was no disturbance of the corneal epithelium. The greater portion of the right side of the face was anæsthetic for the first five days after the operation, but this gradually diminished in extent so that when she left the hospital on Nov. 30, there was a partial return of sensation over the first and third divisions. The cheek, lower eyelid, and upper lip had, however, completely lost their sensibility to touch and pain, and the right side of the tongue was still dull. The patient returned a few days ago complaining of inability to open the mouth, which I remedied by forcible depression of the lower jaw under an anæsthetic, and the use of graduated wedges subsequently. The only other complaint was slight occasional pain and intolerance of light in the right eye.

CASE IV.—Mrs. D., æt. 37. In this patient, who is of a highly neurotic temperament, the disease seems to have

originated about twelve years ago in a bad tooth in the right side of the lower jaw. In 1887, I trephined the lower jaw and removed half an inch of the inferior dental nerve, with temporary relief, but the pain recurred under the right eye, in the tongue and again along the lower jaw. In July, 1890, portions of the inferior dental and gustatory nerves were removed by deepening the sigmoid notch, but the relief given by this proceeding was of short duration, the pain recurring with more than its old severity, and extending down into the neck and up to the temple. On November 5th, 1891, I operated for the removal of the Gasserian ganglion. The operation was performed in the way detailed above, and the skull trephined in two places, one posteriorly having the foramen ovale for its centre, and the other a little anterior and external to it, the intervening bridge of bone being removed by chisel and mallet. In consequence of the thickened state of the third division, it was difficult to draw the disc of bone over the stump, and when this had been accomplished, the foramen was found to be very small. By detaching the dura, the ganglion was seen and even felt by the finger, and by cutting through the different divisions was removed; the opening in the dura for the passage of the root of the nerve was clearly defined, and through this a small quantity of cerebro-spinal fluid trickled, During the removal of the ganglion the dura which had a tendency to bulge was lifted up by a bent spatula. The subsequent history of this case has been satisfactory up to the present. I have alluded already to the fact that some epistaxis and vomiting of altered blood occurred, probably from damage to the Eustachian tube. The wound healed throughout by first intention. One week after the operation the sensation of the right side of the face and tongue was carefully tested, and found to be much decreased, although not totally absent. Two or three weeks later the right eye became somewhat congested and irritable from the development of a crop of small subepithelial vesicles on the lower fifth of the cornea, which burst in a few days and left a superficial ulcer which, however, readily healed under suitable treatment, and the congestion gradually disappeared. The eye pad was in this case retained for six weeks. The patient was examined on January 27th, 1892, and there had been no recurrence of the pain (*a*).

CASE V.—Mrs. B., æt. 37, sent up from Derby Infirmary by Dr. Taylor, had suffered from epileptiform tic of the second and third divisions for seven years. She had teeth

(*a*) But *vide* Addendum, p. 83.

extracted from both upper and lower jaws on the affected side, but this rather increased the trouble than otherwise, and the usual medical treatment had been tried without benefit. Paroxysms were excited by masticatory movements, even after removal of the teeth ; they lasted about two minutes and recurred about every half hour. They could also be elicited by pressure over the points of exit of the second and third divisions. After consultation with Dr. Ferrier, and in consequence of the evident implication of both the supra- and infra-maxillary divisions, it was decided to cut down upon the Gasserian ganglion.

January 16th, 1892.—The usual incision was made, and the zygoma, which in this case was very slender, was exposed, drilled, sawn through and turned down. The anterior saw cut was made close to the malar bone, which was drilled on the slant to clear the root. The coronoid process was cut through, and the temporal muscle turned up and held out of the way. Troublesome bleeding from the pterygoid plexus of veins ensued, interfering for some time with the identification of the trunk of the internal maxillary artery, which was however finally secured. The external pterygoid muscle was scraped away from the skull exposing the great wing of sphenoid together with the anterior margin of foramen ovale. The trunk of the nerve emerging from this was now isolated, ligatured and divided below. The trephine was applied to the great wing of the sphenoid anterior and external to the foramen ovale, the circumference of the trephine track just touching it. Owing to the thinness of the bone in this position the edge of the trephine wounded the dura mater, so that the temporo-sphenoidal lobe was exposed. The trunk of the third division was lifted from the foramen into the trephine hole and traced up to the ganglion, which was then loosened from its connections, and probably the posterior half only removed. Before closing the wound, the coronoid process and about an inch of the temporal tendon were excised. The patient was somewhat collapsed after the operation, and complained of pains in the top of the head and in the limbs. The temperature rose to 101·4° on the second day, but subsequently remained normal. There has been none of the old pain since the operation. I shall anxiously watch the future progress of this case, for I think it highly probable that the anterior half of the ganglion was left completely undisturbed, and the cerebral root but partially divided, an occurrence attributable to the limited opening I made in the skull, to the wound of the dura, and to the troublesome hæmorrhage protracting the

operation. The anæsthetic area in this case is not so complete as in the others, and seems mainly confined to the third division. The sense of taste is completely lost on the right side of the tongue; this was carefully tested by Dr. Ferrier a few days after the operation with salt, sugar and quinine.

A sixth case was operated upon in Chicago on Nov. 7th, 1891, by Professor Andrews in a similar manner. The patient was a woman, æt. 50, who had suffered for five years from "frightful pain along the inferior maxillary division without being able to obtain any relief, the act of swallowing being especially associated with the paroxysms." He trephined the base of the skull by the side of the foramen ovale, and broke up the ganglion thoroughly with a curette. The patient who was very weak felt the shock considerably, but rallied after a few hours, and was free from neuralgic pains. There was complete benumbing of all the parts supplied by the ganglion, and swallowing was no longer painful. The motor oculi nerve was paralysed, showing that it had been injured, probably by the curette. In ten days she was able to return to her home, fifty miles distant, although the wound was not quite healed, and it suppurated slightly afterwards. I had another communication from Prof. Andrews recently, dated Jan. 15, 1892, stating that this patient had remained free from pain; that the paralysis of the motor oculi proved only temporary, but there was a slight tendency to pericorneal ulceration of the right eye.

He also sends me particulars of another case in a woman, 62 years of age, the disease being on the right side, and involving the second and third divisions. He had previously removed the inferior dental branch close to the foramen ovale. The operation was performed in the middle of last December in the same way, by trephining just external to the foramen ovale, and removing the ganglion with a sharp curette. There was troublesome hæmorrhage during the operation. Up to the time of his writing the patient was perfectly free from pain.

Results of Operation.

In considering the results of partial or complete removal of the Gasserian ganglion, the first question which has to be answered is naturally, "What effect has this proceeding upon the pain?" Up to the present time we are able to

give a satisfactory reply; all the five patients whom I have treated in this way have remained free from the typical and terrible paroxysmal attacks from which they had previously suffered. It is true that my first case was done only twenty-two months ago, and the last only sixteen days; consequently, it is too early to speak with confidence as to the permanent character of the relief; but the results hitherto obtained are sufficiently encouraging to lead me to continue in the same line of action. Absolute immunity from any kind of pain can hardly be expected after such a considerable disturbance of the structures at the base of the skull, and for some time there may persist a sore and stiff sensation in the region operated on and probably some wandering pains about the head; these are not considered of any moment by patients who have previously suffered such intense agony. The interference with the movements of the lower jaw is undoubtedly inconvenient, and renders the process of mastication a little difficult; but this may be avoided in the future by the removal of the coronoid process.

As to the effect upon the distribution of the sensory fibres of the fifth nerve, it is interesting both from the clinical and physiological sides to observe the rapid diminution of the anæsthetic area, and it would appear that sensation is re-established by the neighbouring branches much in the same way as collateral anastomosis takes place in the vascular system. This phenomenon is a fact which cannot be disregarded prognostically, although it is not necessarily the precursor of a relapse. The appearance of the side of the face operated on is characteristic of trophic disturbance; the skin has a shiny somewhat injected look, whilst the hollows in the temporal, pterygoid, and maxillary regions on that side clearly demonstrate the existence of muscular atrophy and cicatricial contraction.

The effect upon the nutrition of the eyeball is decidedly serious. In the first case, as previously mentioned, the organ was lost from suppurative panophthalmitis, and in two of the other cases the nutritive state of the globe was for the time considerably depressed. It is probable that the trophic centres are contained in the upper and

anterior segment of the ganglion, and if this be so, the chances of damaging the eye may be lessened by leaving that portion intact, even though the trunk of the nerve be divided behind the ganglion. On the other hand, the interference with one part of the ganglion may induce degenerative changes in the remainder which will effectually prevent a recurrence of the malady, and yet will not be sufficient to cause permanent damage to the eye.

Such are the results, Mr. President and Gentlemen, both of my own observations and experience together with that of others in this department of surgery, and from them I venture to draw two very definite conclusions: (1) that in severe cases of epileptiform neuralgia, both medical and surgical treatment have hitherto been unavailing to give permanent relief: and (2) that extirpation of the Gasserian ganglion through the base of the skull, though admittedly difficult, need not endanger life, and at present holds out the best prospect of dealing with these intractable forms of Trigeminal tic. The test of time and further experience can alone decide what value will be finally attached to this measure; but at any rate the outlook is hopeful and let us trust the future will not belie our present expectations.

In conclusion, once more let me thank you for the honour you have done me in electing me to this position, and for the patient hearing you have granted me.

APPENDIX.

SINCE the above lectures were delivered I have operated on a sixth case with, I regret to state, a fatal result. The following are the notes of the case :—

Mrs. S——, a widow, æt. 68, but looking much older, was admitted to King's College Hospital, on February 19th, 1892. About five years previously she was seized with acute pain in the skin over the right mastoid process, and the adjoining part of the neck. It was noticed particularly on washing, and was confined to this area for about a year; it was paroxysmal in character, the attacks being only occasional and lasting two or three minutes. Two years later the whole of the right side of the face became affected, the pain appeared to start in the skin in front of the angle of the jaw, radiating along the ramus and into the infra-orbital region. The paroxysms became intensified in duration and frequency, and the patient was confined to bed during the winter of 1888-89 for ten weeks. In spite of treatment at Leicester and Buxton by drugs, baths, and electricity, in addition to which all her teeth were removed, the pains were increased in severity and extent, affecting the other side of the face and forehead, and the attacks became almost constant. On one or two occasions slight improvement seemed to follow the treatment, but such was only

temporary. "Life had been miserable for the last year or two."

On admission, the patient was evidently in great pain, the paroxysms recurring with great frequency, being elicited by draughts or sudden movements of the head, neck or jaw, and also by pressure over both infra-orbital foramina; but the pain on the right side was evidently more severe and lasting than that on the left. The sites of both supra-orbital nerves were affected, and there was a painful and injected patch over the right malar bone, and another over the right lower canine fossa. The patient had all her faculties, except being rather deaf; arcus senilis was marked in both eyes, and the arteries were somewhat atheromatous. Urine 1015, acid, no albumen, no sugar. After an attack of pain there was free perspiration.

The operation was performed by me on February 25th, 1892, in the usual way as detailed above, and after the usual precautions. Chloroform was the anæsthetic employed, and I was assisted by my colleagues Messrs. Barrow and Carless. The bleeding from the pterygoid veins was very free and copious, and considerable time was occupied in arresting it to a sufficient extent to continue the operation. Only one trephine opening was made, at the spot represented in Fig. 12, and this was subsequently enlarged by the use of cutting-pliers and chisel and mallet. The edge of the trephine unfortunately wounded the dura on the outer segment of the circular incision the skull being very thin at that spot. After the disc had been lifted out and during the process of enlarging the opening, some cartilaginous tissue was removed, and on further investigation it was evident the Eustachian tube had been encroached upon. The dura was now separated from the skull around the opening, and the second and third divisions of the nerve traced up to the ganglion, and the posterior half removed. The wound was carefully irrigated, and the parts replaced in position with the exception of the coronoid process which was snipped away.

The patient was considerably collapsed after the operation, the temperature falling to 97° F. At 4 a.m. on the following morning it rose to 101·2°, and she became

restless and complained of occipital and frontal headache. The pulse became very rapid, varying from 120 to 130, the respirations increased to 40 per minute, and she gradually sank into a state of coma in which she died about 48 hours after the operation.

A complete post-mortem examination of the body was not permitted, but I opened the skull and was able to examine the base of it from within. The posterior half of the ganglion had been completely removed, the anterior half being surrounded by cloudy blood-stained serum, which on microscopic examination revealed the presence of pus corpuscles. There was considerable congestion of the right hemisphere together with some softening of the temporo-sphenoidal lobe in the neighbourhood of the operation. I fear there can be no doubt that in this case the wound became septic in spite of all precautions, the opening of the Eustachian tube being the possible cause of the infection.

I have recently (June, 1892,) seen Case IV, and the woman who is of a highly neurotic temperament complains of a return of the pain in the temporal and maxillary regions. She flinches when these parts are touched; but on distracting her attention, the same parts can be handled with impunity. The tongue is still comparatively anæsthetic on the right side. I do not consider that this case can be fairly looked upon as an instance of relapse, for there has been no return of the paroxysmal pain.

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