DISEASE AND SURGERY OF THE FIFTH NERVE.

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Patients suffering from facial pain are frequent visitors to the otolaryngologist. Mild and medium degrees of the fifth nerve involvement are common, and severe types are not rare. To ascertain the cause of these facial aches and pains, to eliminate that cause and thus cure the painful affection is a daily problem. Very often these ailments are diagnosed "only a neuralgia," just as though that were an invariable, definite, disease for which a specific anti-neuralgic drug is always available. Such simplicity in dealing with this troublesome affection no longer satisfies medical thought. Hence scientific investigation of this, as of many other subjects in medicine and surgery that were formerly passed over lightly is demanded, and more searching methods of examination have shown that the term neuralgia in its former generally accepted meaning was much abused; also that the neuralgias, like most other diseases, are caused by pathologic changes that may be discovered, if only sufficient energy and the known existing aids to diagnosis be employed.

I need only to remind you that the trifacial nerve supplies with sensation nearly all the structures with which the otolaryngologist deals. The nerve may, therefore, aptly be termed the special sensory nerve of the otolaryngologist, for with it this specialist must deal in some measure in many of his patients. Treatment of a surgical nature, either of the exterior of the head, or of its interior cavities, brings the operator into immediate relation with some branch of the trigeminus, which supplies the envelopes of the brain, the accessory nasal sinuses, the whole nasal interior, the jaws, teeth, tonsils, palate and orbits; on the exterior it supplies the nose, face, forehead and ear. Besides this sensory distribution the branches of the fifth nerve supply the anterior two-thirds of the tongue with special taste, while the powerful muscles of mastication are innervated by branches from its motor root. This nerve with its ganglia and communicating branches from other nerves and ganglia, when diseased, furnishes a difficult field of study, because of the great depth within the soft and osseous structures of the head at which these ganglia and connecting nerve branches are situated. The problems presented by affections of the trigeminus are, therefore, often obscure to such an extent that a solution may be reached only when, first, a definite knowledge of the anatomy of the whole head is before the investigator; second, when the nasal interior and

all its accessory sinuses have been inspected by accurate methods; and third, when the surgeon may call to his aid the service of the oculist, roentgenologist, internist, dentist, neurologist, pathologist, bacteriologist and serologist. Of course, not all cases of disease of the fifth nerve will require the services of such a large number of specialists, but the worst cases may demand all before a positive conclusion is possible.

Affections of the fifth nerve may vary in severity from nagging little pains, either constant or intermittent, up to pain so severe and constant as to be unbearable. The term neuralgia is commonly used to designate all varieties of the disease, while those more careful in the use of terms employ neuralgia, neuritis and tic douloureux. In reference books and essays on the subject I find much confusion in the meaning of the terms used, but the best classification would seem to be one in which the term neuralgia is used to designate a pain where no pathological reason is discoverable; neuritis when the nerve trunk is inflamed, the tic douloureux where the sole pathology is in the Gasserian ganglion. Since many cases of so-called neuralgia are clearly caused by infection it would seem better were the term infective neuritis used in all such. Many local and general derangements have been assigned as the cause of facial neuralgia. It is probably never a primary disease although there are cases in which no pathology of any kind can be found. Among proven causes may be mentioned (a) the general infectious diseases including typhoid, malaria and syphilis. The latter disease may act in two ways to produce neuralgia: First, infection of the nerve itself, and second, pressure on some nerve trunk from a nearby gumma. (b) Extra-neural pressure from any cause, as from a tumor, an osseous growth springing from the wall of the neural foramen, from traumatic or other infiltrates in or near the nerve trunk. (c) Infection of the nerve itself. This is no doubt the most common cause and in facial neuralgias, perhaps, is a more frequent cause than all others put together. According to Behans, the toxic cause may arise from tonsillitis, influenza, malaria, gout, rheumatism, gonorrhoea, or, indeed, from any general infection. This author states that the toxic material circulating in the blood lodges inside the nerve sheath where it sets up a true neuritis. In addition to the sources given above by Behans as a cause for nerve infection, others should undoubtedly be more specifically stated, namely, suppuration of the nasal accessory sinuses, purulent infections at the roots of the teeth, and pyorrhoea alveolaris. The frequency with which suppurative disease of the sinuses, teeth and gums, taken together with the fact that the branches of the fifth

nerve which supply the several sinuses, teeth and mouth, are intimately exposed to these large suppurative areas, would point strongly to the almost inevitable infection of the nerve endings in all such cases. Clinical evidence on this point bears out the preceding supposition, for it is undoubtedly true that some form of neuralgia is a frequent complication of both sinusitis and pyorrhoea. A suppurating accessory sinus may also cause neuralgia because of pressure from pent-up fluids, especially in acute sinusitis, and in chronic cases from the enormous thickening of the lining membrane which results, and which both pinches and causes infection of the nerve terminals.

Brophy in his new work on oral surgery states that the most common cause of trifacial neuralgia lies in disease of the teeth. This author was trained as a dentist and has been a leader in dental thought; therefore his statement may be regarded as authority from the dental standpoint. The chief sources of neuralgia emanating from the teeth are, according to Brophy, unerupted teeth, malposition, injuries during extraction, dental tumors, exposed nerves in the pulp, unskillfully placed fillings and pyorrhoea.

A thorough search for the cause of a given case of neuralgia is entirely essential, since it is scarcely probable that either medical or surgical means of cure will be worth while until the cause is known. The examination in all cases should include the most thorough investigation of the tonsils, adenoid, teeth, gums, mouth, nose, eyes, and all the nasal accessory sinuses. If a satisfactory cause is not found in any of these, and suspicion rests upon the sinuses or teeth, x-ray plates should be obtained. I have in several instances been surprised and gratified on finding that the x-ray plate showed an unerupted tooth, or a thickened mucosa in one or more sinuses which discharged only small amounts at intervals and was on that account overlooked. A perforated nasal septum, or a swelling of the septum may point strongly to lues, and this suspicion may be further borne out by finding healed scars or open ulcers in the throat or mouth. If uncertain a Wassermann test may give the information most wanted. Other blood tests may be necessary in malarial districts. The three points of examination, namely, the sinuses and foci of infections about the nose and mouth, x-ray examinations and blood tests, have done much to eliminate the mystery as to the cause of neuralgia and to place it among diseases whose cause is known.

Nearly every writer I have consulted on the subject of neuralgia mentions anemia as a prominent cause. I have observed anemia in many of my cases, but do not think it the cause of the neuralgia,

for in nearly every such case there has been found a focus of suppuration which fully accounted for the anemic state, especially when considered in its relation to the facts that the patient frequently swallows considerable quantities of pus, that the pain disturbs the patient's sleep and that nutritional disturbances would inevitably result.

To name the drugs that have been recommended for the cure of facial neuralgia would be to include all in the *materia medica*, and many besides. But I desire to deal chiefly with the surgical side. Efficient surgical treatment of neuralgia of the fifth nerve may include the surgical treatment of any part of the head, but especially of the dura mater, the nose, the nasal accessory sinuses, the nasal interior, the tonsils, palate, teeth, nasopharynx and eyes. In other words, any of the structures supplied by this nerve. Surgical treatment should not be applied to any branch of the nerve itself in any case in which the cause of the disease can be made out, until the cause, when of a surgical nature, has received surgical care. As an example, should sphenoiditis be found in conjunction with neuralgia of the second division it would be faulty surgical practice to resect the nerve before eradicating, in so far as possible, the disease within the sinus. I have seen cases which had been treated by partial nerve extraction when there was present, as a most probable cause of the neuralgia, a chronic suppurative disease of one or more sinuses. Certain neuralgias persist, however, even after every nasal sinus or other suppurative cause has been surgically eradicated, and in such cases destruction of the function of the nerve trunk or of the Gasserian ganglion must be considered. When the probable causes have been removed in so far as possible, but without relief, surgery of the nerve trunk or of the Gasserian ganglion is necessary.

The chief measures employed at present are, first, the injection into the nerve trunk or its ganglion of origin of some substance that more or less permanently destroys the nerve and blocks sensation; and second, destruction of a portion of the nerve trunk and third, removal of or destruction of the sensory root of the ganglion. All these plans are advocated and all have a recognized value. The selection of one or the other plan must depend largely upon the individual to be treated. The injection of alcohol or osmic acid into the nerve trunk or ganglion should be given preference in the young, in the earlier stages of any neuralgia, in those advanced in years, and especially in those in whom a general anesthetic is contraindicated by atheroma, kidney or other lesions. Patrick, Camp and Hartel are representative advocates

of the alcohol injection plan. Patrick's experience with this method may be taken as typical of our present knowledge of the technic and value of this method. This writer (*Journal A. M. A.*, Jan. 20, 1912) states that the injection of the nerve trunks with alcohol is easy, effective, not painful, not dangerous and that the cure resulting lasts from six months to four years. No anesthetic is used, and the injection may be given in the office, or home of the patient. Stiffness of the jaw, puffiness of the eyelids, ecchymoses, closure of the eye from swelling and other inconveniences may result. Alcohol injection must not be regarded as a cure, for, as Patrick points out, "No procedure is a cure except the removal of the sensory portion of the Gasserian ganglion."

The point of injection of the alcohol should be either the Gasserian ganglion or the foramina of exit of the first and second divisions of the nerve from the skull. The first division of the nerve is best injected at the supra-orbital notch. Although writers in general usually state that these injections are easily made, no one, in so far as I am aware, claims to make perfect injections in all cases. Patrick in 500 injected cases gives the following frank statement as to success and failure from the procedure: "Injections of the infraorbital branch, twenty-five per cent failures, forty-two per cent partial failures and thirty-three per cent successes. Injections of the third branch were twenty-seven per cent misses, forty-five per cent partial success and twenty-eight per cent wholly successful." More than one injection was required in many of the cases. Many of the injected cases must be treated later by the more radical nerve operations. Most of the cases on which I have operated personally for resection of the nerve trunks had been injected previously either by myself or others, and some of the injections had been made by operators of the widest experience, only to have the pain return in all its former severity a few weeks later. I shall give no description of the technic of nerve trunk injection for the reason that this can be learned only on the skull and cadaver; moreover, excellent technic has already been described. I can agree fully with writers who state that the injection is easy, painless and safe, but I cannot agree with those who say it is easy to penetrate a given foramen or to inject the nerve trunk itself, because such has not been my experience. The anatomic build of skulls is so very different, and the amount of soft structures overlying the skull so varying that each case requires a somewhat different manipulation in order to reach the desired spot, and sometimes success in actually doing so requires more than one effort.

Injections of alcohol and carbolic acid into Meckel's ganglion have been made by Sluder and others following the publication of his several papers on the relation of the sphenopalatine ganglion to the nose, in the transactions of the American Laryngological Association, 1909, and subsequently. Dr. Sluder has shown more conclusively than any other investigator the intimate anatomic relationship between the posterior ethmoidal and sphenoidal sinuses and the sphenopalatine ganglion and its branches. I have recently made several dissections of the sphenomaxillary fossa on the cadaver, and have thereby confirmed Sluder's deductions concerning close proximity of Meckel's ganglion to the posterior ethmoidal cells and sphenoidal cavity and therefore the probability of toxic involvement of this ganglion and its branches in any case of post-ethmoidal or sphenoidal suppuration in which the relationship of the sinus and nerve structure is intimate. I have not been able so far, however, to obtain as good results from the injection of the ganglion as have been reported by Sluder in his several papers. In addition to the value of the method of injection pointed out by Sluder, I believe great assistance may be derived from the plan of injecting the ganglion in cases where the second division of the nerve has been resected for neuralgia, but in whom the resection, for some reason, has not included and destroyed the branches to Meckel's ganglion.

Cases of trigeminal neuralgia that persist after the removal of all known causes, and that continue or return after one or more alcohol injections of the nerve trunk will require surgery of the Gasserian ganglion or of one or more of the nerve trunks. Many able surgeons have been interested in the surgery of this nerve, among whom are Carnochan, Mears, Rose, Kocher, Cushing, Frazier, Spiller, Hartley, Krause and Keene. Several operative procedures take the name of one or the other of these operators. In general it may be said that in the most recent cases of neuralgia or tic that surgery of the nerve trunks should be performed, while in the cases of long standing, especially of the ascending variety of the nerve affection in which the ganglion itself is the chief seat of the disease, Gasserectomy only would offer hope of cure.

Operations on the nerve trunks may be superficial or at the exit of the nerves from the skull. My own experience with cases which were operated by neurectomy or avulsion of the nerve trunk at any considerable distance from the foramen of exit from the skull has been disappointing. I have seen and operated on the trunks of nerves that had been operated both by myself and others, some who were surgeons of first rank, in which the nerve

had been but superficially avulsed, and which were followed quickly by a return of the former pain. There are two reasons for the return of the pain. First, many investigators have noted the rapid regeneration of nerve trunks following the exsection of even considerable portions. In experiments on the facial nerve of the dog, made by myself in 1912,* I found that on severing this nerve completely and immediately suturing the severed ends, function was restored in three months, it being found on histologic examination of the nerve trunk at the point of section that regeneration of the nerve was complete. Partial regeneration of the nerve trunk and partial restoration of function occurred after complete severance of the nerve in three months when the severed trunks were merely placed in apposition but not sutured. After a section of the nerve in which 4 mm. were removed entirely some movement of the facial muscles were plainly noticeable after four months. Since sensory nerve trunks regenerate in shorter time than motor nerves it is evident that such trivial operations as mere section of the trunk, or avulsion or exsection of a short portion will do no permanent good. Second, in superficial operations on the nerve trunk all the diseased branches of that trunk are not included. For example, avulsion of the infraorbital nerve at its exit from the infraorbital foramen, or of the mandibular branch at the mental foramen results in the nerve breaking at the margin of the foramen or a short distance within the canal and therefore the nearest branches are usually not disturbed. I have made numerous experiments on the avulsion of these nerves at their superficial foramina on the cadaver and found that it is only occasionally possible in case of the infraorbital nerve to secure the anterior dental branch even though the nerve at the foramen were freely exposed and Thiersch's method of twisting the trunk by means of forceps be carefully employed. Superficial methods are therefore not reliable in the surgery of the trifacial nerve. When the supraorbital division alone is involved avulsion is usually effective if all the branches are included. Avulsion of the supraorbital nerve is much easier and therefore often more successfully performed than on the second and third divisions. The reason, of course, is that the nerve trunk does not traverse any osseous canal, its exposure throughout its course is easy and the avulsion is accordingly more complete. My most troublesome cases have been those in which the supra- and infratrochlear or nasal branches are involved in the neuralgia. These branches are oftenest missed in the operation, and when this unfortunately happens the patient may make as much

*Proceedings International Otological Society.

complaint of the comparatively localized pain about the inner canthus of the eye and the external half of the nose as he did of the more diffuse neuralgia for which the operation was performed.

From experiments on the cadaver and from personal experience in operated cases on the living, I believe that a modified Rose's method of operation on the second division of the trifacial nerve offers best results. I follow the plan of making the incision over the cheek one centimeter below the orbital margin, dissecting the nerve trunk from the tissues adjacent to the foramen and then ligating with a stout thread that is to be left until the completion of the nerve resection. The periosteum of the lower orbital margin is then incised and the periosteum of the entire lower third of the orbit is lifted back to the sphenomaxillary fissure. The contents of the orbit are lifted upward from the orbital floor sufficiently to expose the course of the infraorbital canal. Killian's angular frontal sinus chisel is used to cut away the upper wall of the infraorbital canal throughout its entire length. The nerve trunk is then lifted from its bed by means of the attached ligature and the dissection is continued until the foramen ovale is reached at a distance of about 45 mm. from the infraorbital foramen. When the nerve trunk has been freed for this distance it is grasped by an artery forceps as deeply as possible and the nerve is twisted away by the Thirsch method. On reaching the sphe-no-maxillary fissure dense fibrous structures are met which render somewhat difficult the dissection of the nerve which is necessary to the further dissection in the pterygo-maxillary fossa. This dissection is, however, not more difficult than is sometimes encountered in working around a sharp deflection posteriorly in the performance of a submucous resection of the nasal septum, and experience with the latter operation is valuable in the deep nerve work here described.

The operations for the resection of the infraorbital branch recommended by both Kocher and Carnochan involve opening the maxillary sinus and temporary resection of a portion of the malar and maxillary bones. It seems to me that extensive resection of these bones is usually not necessary, and that any operation on the nerve which opens the maxillary antrum is a surgical misfortune. In two of my cases the antrum was opened, one by accidentally penetrating the mucous membrane of the antrum while performing the operation for avulsion of the nerve above described, and the other intentionally while following a modified Kocher method. Both cases ultimately recovered both from the operation and the neuralgia, but the wound in each became infected from the maxillary antrum, the skin sutures broke down, prolonged treatment was necessary,

and more thickening of the cheek with scar tissue resulted than was necessary.

In following any of the plans adopted by surgeons for the treatment of neuralgia of the third division two points must be borne in mind: First, that a very considerable portion of the nerve trunk must be removed from the dental canal in order to be curative for any great length of time, and second, that in making the necessary external incision over the jaw, injury to one or more branches of the facial nerve may result with corresponding facial palsy. The facial nerve is best avoided by a horizontal incision over the site of entrance of the third division of the facial into the dental canal, the same to be carried down to the masseter muscle, the fibers of which are then separated perpendicularly and the jaw bone exposed. A perpendicular groove is chiseled into the bone down to the nerve, following its course for three-fourths inch. This extensive exposure of the nerve trunk enables the operator to loosen the trunk freely, to grasp it firmly in the jaws of the forceps, and to make traction in the direction of the dental canal. I have made experiments on removal of the nerve from its canal in the cadaver and find that a very small section only of the nerve trunk can be withdrawn by any means unless the exposure is of considerable length and the nerve is dissected freely from the canal. The difficulty is due to the fact that the nerve is apparently well imbedded in connective tissue throughout the entire length of the canal, and besides gives off the several dental branches, all of which fasten the nerve quite firmly. Even with free dissection and the use of every precaution in pulling and twisting the nerve from the canal it was found that the break occurred only a little beyond the point where the bone was removed. Owing to this fact, as well as to the further fact that a nerve regenerates very rapidly in an osseous canal, it is necessary to expose the trunk again at its exit from the mental foramen, to chisel away the outer canal wall, and to avulse as much of this portion of the trunk as possible.

I have had no experience on the living with Kronlein's method of resection of the zygomatic process, reflection of the tissues from the underlying fossa and from the foramen rotundum and foramen ovale, whereby both the second and the third division of the fifth nerve may be resected at their exits from the skull, but performance of this operation on the cadaver has given me the feeling that Gasserectomy by the method of Cushing would be quite as easy and possibly as safe, and should therefore in proper cases be the operation of choice.

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