Neurosurgical Classic—XIII

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During the final two decades of the nineteenth century, a few general surgeons began the development of neurological surgery. Among the diseases that these surgeons sought to cure was tic douloureux, which had been resistant to all forms of treatment attempted previously. The independent efforts of four men—Victor Horsley, Frank Hartley, Fedor Krause, and Charles Frazier—were rewarded by the development of an excellent operation for the permanent relief of this condition.

By 1890, tic douloureux had been known as an entity for more than two centuries. But even after its relationship to the trigeminal nerve had been discovered, no treatment of lasting value had been developed. Various medicines had been tried, systemically and locally, without effect. Counterirritation had been proved worthless, and the destruction of the peripheral trigeminal branches by injection or operation had been shown to afford only temporary relief. Numerous ingenious operations then had been devised for the interruption of the major trigeminal branches close to their initial exits from the skull. However, none of these procedures gave lasting relief. For more than a century prior to 1890, many intelligent attempts at the cure of tic douloureux had been made, but all had been unsuccessful. The problem was solved by a combination of advances over the ensuing eleven years.

After it had been demonstrated that intracranial operations could be performed successfully, two related types of operations for tic douloureux were proposed. At first, extirpation of the gasserian ganglion was attempted. William Rose, in 1890, developed a procedure for the piecemeal avulsion of the ganglion through an enlarged foramen ovale. Because of poor exposure, frequent hemorrhage, and incomplete removal of the ganglion, this operation proved unsatisfactory. In 1891, Frank Hartley devised an extradural temporal approach to the gasserian ganglion to facilitate intracranial neurotomy of the second and third trigeminal divisions. This approach proved to be the technical key that opened the way for later advances. Six and a half months after Hartley’s first operation, and unaware of it, Fedor Krause duplicated this operation. However, Krause carried the operation a step further in 1893 when he first completely removed the gasserian ganglion successfully. Two years later, he analyzed 51 gasserian ganglionectomies (performed by the Hartley-Krause approach) which had been reported in the medical literature. The over-all mortality for these 51 cases was approximately 10 per cent. Harvey Cushing then modified the Hartley-Krause approach by minimizing traction on and subsequent hemorrhage from the middle meningeal artery. The result was a reduction in mortality to 5 per cent by 1905. After this, extirpation of the gasserian ganglion was abandoned in favor of the second type of operation which had been developed for tic douloureux.

Foreseeing the probable difficulties of gasserian ganglionectomy, Victor Horsley proposed retrogasserian neurotomy instead. He and William MacEwen worked independently to develop such a procedure. After trial operations on monkeys and human cadavers, Horsley in 1890 attempted avulsion of the trigeminal root in a very ill woman who had had two previous extracranial operations for tic douloureux. Because of the unfortunate operative death of this patient, and the simultaneous early successes with gasserian ganglionectomy, similar attempts at dividing the trigeminal
root were abandoned temporarily. David Ferrier (1890), William Spiller (1898), and Lewellys Barker (1900) each proposed that section of the root might afford a permanent cure, but it was not until 1901 that this again was attempted. In that year, Charles Frazier performed such an operation, using the Hartley-Krause approach to the nerve. His successes established retrogasserian neurotomy as the operation of choice, and later refinements minimized its morbidity and mortality.

Victor Horsley's description of his first retrogasserian operation is reproduced below, followed by the report of the first extradural temporal approach to the gasserian ganglion by Frank Hartley, and the translation of the paper by Fedor Krause describing the first gasserian ganglionectomy by the Hartley-Krause approach. The classical paper by William G. Spiller and Charles H. Frazier in 1901, which established retrogasserian neurotomy, will be reproduced in a subsequent issue of the Journal of Neurosurgery.

References

Neurosurgical Classic—XIII


REMARKS ON THE VARIOUS SURGICAL PROCEDURES DEVISED FOR THE RELIEF OR CURE OF TRIGEMINAL NEURALGIA (TIC DOULOUREUX).*

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ASSISTED BY

JAMES TAYLOR, M.D.

Pathologist to the National Hospital for the Paralysed and Epileptic;

AND

WALTER S. COLMAN, M.B.

(Concluded from page 1193.)

Operation for Removal of the Gasserian Ganglion and the Division of the Fifth Nerve behind the Latter.--In considering the possibility of relieving cases of invertebrate neuralgia where recurrence of the pain had taken place, I thought one might be able to remove the Gasserian ganglion or divide the fifth nerve behind it, and I made, some years ago, dissections to see how far the Gasserian ganglion could be separated from the cavernous sinus. On first exposing the ganglion from the pterygoid fossa and opening the middle fossa of the skull freely following up the inferior division of the fifth nerve, I found that one could raise the inferior division and so the lower half of the ganglion from its bed in the dura mater without damage to the carotid artery in the canal or to the cavernous sinus, but that when one attempted to strip up the upper half of the ganglion from the cavernous sinus it invariably tore the wall of that cavity. For this reason I believe that the operation of complete removal of the Gasserian ganglion is not possible, but that in the operation which Mr. Rose has subsequently described only a portion of it can be taken away.

Finding this to be the case, I then considered the possibility of dividing the fifth nerve behind the ganglion. It is well known that the fifth nerve enters the dura mater just beneath the edge of the tentorium, and that it runs afterwards in a small but roosey canal in the dura mater, joining the Gasserian ganglion, which lies in a similar cleft on the upper surface of the petrous bone and on the roof of the carotid canal. Some experiments on the monkey to expose the crura had shown me that it was possible to expose the temporo-sphenoidal lobe, and then, by raising the brain carefully with a broad retractor, to lay bare the floor of the middle fossa of the skull. On trying this on the dead body I found that it was perfectly possible in man also, the only trouble being the small veins which come from the temporo-sphenoidal lobe and which enter the petrosal sinuses. If these be ruptured the hæmorrhage is very free, and, although not dangerous to life, nevertheless very effectually hinders the performance of the operation.

This exposure of the temporo-sphenoidal lobe in man I have carried out by making a large temporal flap, starting from the anterior extremity of the zygomatic process, and running upwards to the temporal ridge, following that line and descending along it to the asterion. The temporal muscle, after being separated from the bone, is then best removed, so far as its posterior half is concerned, and then the whole of the squamous portion of the temporal taken away by means of a trephined hole and suitable bone forceps. Anteriorly the middle meningeal artery may be dealt with where exposed, being simply ligatured in the dura mater. The dura mater is then to be opened along the full length of the area of bone removed, and the temporo-sphenoidal lobe thus 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 upwards, and the floor of the skull is then easily seen and illuminated with the electric light. The guide to the fifth nerve now is the upper border of the petrosal bone. The lobe being raised a little more, the edge

* Reprinted (pp. 1249-1252) from the British Medical Journal, 1891, 2: 1139-1143; 1191-1193; 1249-1252, with the kind permission of the Editor.

23 By the kind help of Drs. Savill, Lunn, and others.
<table>
<thead>
<tr>
<th>No.</th>
<th>Sex &amp; Age</th>
<th>Duration</th>
<th>Presumed Exciting Cause</th>
<th>Nerve Distribution Affected.</th>
<th>Trophic Changes</th>
<th>Previous Treatment</th>
<th>Operative Treatment</th>
<th>Mode of Healing</th>
<th>Notes</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M., 60</td>
<td>7 yrs.</td>
<td>Worry</td>
<td>Left 2nd division, pain in supra-orbital region</td>
<td>None</td>
<td>Extraction of all teeth, usual drugs, and exanthem in upper jaw</td>
<td>Mar. 2, 1889, Removal of 2nd division from antrum</td>
<td>First intention</td>
<td>—</td>
<td>Pain in upper gum remained.</td>
</tr>
<tr>
<td>2</td>
<td>F., 65</td>
<td>7 yrs.</td>
<td>Exposure to cold</td>
<td>Left 2nd division</td>
<td>None</td>
<td>All usual drugs removed</td>
<td>Nov. 19, 1889, Removal of inferior dental removed</td>
<td>First intention</td>
<td>—</td>
<td>Complete relief for 7 months.</td>
</tr>
<tr>
<td>3</td>
<td>F., 60</td>
<td>8 yrs.</td>
<td>Cold and eating teeth</td>
<td>Right inferior dental</td>
<td>None</td>
<td>Teeth extracted</td>
<td>Aug. 21, 1887, Extraction of 1 in. of 3rd division</td>
<td>First intention</td>
<td>—</td>
<td>Complete relief when last heard of.</td>
</tr>
<tr>
<td>4</td>
<td>M., 61</td>
<td>4 yrs.</td>
<td>None</td>
<td>Right 2nd division</td>
<td>None</td>
<td>Swelling of right cheek and lower lip</td>
<td>May 24, 1887, Removal of inferior dental</td>
<td>First intention</td>
<td>—</td>
<td>Complete relief for 3 weeks before operation.</td>
</tr>
<tr>
<td>5</td>
<td>F., 55</td>
<td>7 yrs.</td>
<td>None</td>
<td>Right inferior dental and lingual</td>
<td>None</td>
<td>Swelling of right cheek &amp; upper lip; herpetiform pustules; conjunctivitis, herpes and swelling of lower lip</td>
<td>Nov. 11, 1886, Removal of 2nd division from spheno-maxillary fissure</td>
<td>First intention</td>
<td>—</td>
<td>Complete relief for 2 years.</td>
</tr>
<tr>
<td>6</td>
<td>M., 38</td>
<td>6 yrs.</td>
<td>Exposure to cold</td>
<td>Right inferior dental</td>
<td>None</td>
<td>None</td>
<td>Feb. 8, 1888, Removal of inferior dental and lingual</td>
<td>First intention</td>
<td>—</td>
<td>Disappearance of trophic change, and relief for 1 year.</td>
</tr>
<tr>
<td>7</td>
<td>F., 58</td>
<td>2 yrs.</td>
<td>Movement excites pain</td>
<td>Infra-orbital</td>
<td>None</td>
<td>All teeth on affected side extracted</td>
<td>Aug. 7, 1888, Nerve cut in infra-orbital</td>
<td>First intention</td>
<td>—</td>
<td>Complete relief for a year.</td>
</tr>
<tr>
<td>8</td>
<td>M., 64</td>
<td>7 yrs.</td>
<td>Cold</td>
<td>Left 2nd and 3rd divisions</td>
<td>None</td>
<td>None</td>
<td>Aug. 21, 1888, Removal of inferior dental and lingual</td>
<td>First intention</td>
<td>—</td>
<td>Relief for a year.</td>
</tr>
<tr>
<td>9</td>
<td>F., 55</td>
<td>2 yrs.</td>
<td>None</td>
<td>Left 2nd and 3rd divisions</td>
<td>None</td>
<td>Swelling of right lower lip</td>
<td>Aug. 10, 1891, Removal of inferior division at foramen ovale</td>
<td>First intention</td>
<td>—</td>
<td>Temporary relief; recurrence in 1st division; dementia.</td>
</tr>
<tr>
<td>10</td>
<td>M., 53</td>
<td>6 yrs.</td>
<td>Exposure to cold</td>
<td>Right inferior dental and lingual</td>
<td>None</td>
<td>All drugs, some teeth removed</td>
<td>Nov. 22, 1886, In. of inferior dental and lingual removed</td>
<td>First intention</td>
<td>—</td>
<td>Complete cure. Herpes also in right shoulder for 4 years before operation.</td>
</tr>
<tr>
<td>11</td>
<td>F., 68</td>
<td>15 yrs.</td>
<td>Getting wet</td>
<td>Right inferior division</td>
<td>None</td>
<td>None</td>
<td>Jan. 23, 1889, Removal of inferior dental and lingual</td>
<td>First intention</td>
<td>—</td>
<td>Temporary relief, side by side.</td>
</tr>
<tr>
<td>12</td>
<td>F., 54</td>
<td>5 yrs.</td>
<td>—</td>
<td>Right 2nd division</td>
<td>None</td>
<td>Swelling of right upper lip; unilateral furring of tongue</td>
<td>Jan. 15, 1886, Excision of part of right infra-orbital</td>
<td>First intention</td>
<td>—</td>
<td>Relief so far.</td>
</tr>
<tr>
<td>13</td>
<td>M., 49</td>
<td>12 yrs.</td>
<td>Pressure excites pain</td>
<td>Left infra-orbital</td>
<td>None</td>
<td>None</td>
<td>May 8, 1889, Removal of 2nd division at foramen rotundum; antrum opened</td>
<td>First intention</td>
<td>—</td>
<td>Slight cough. Care. seas from using strong carbolic.</td>
</tr>
<tr>
<td>14</td>
<td>F., 63</td>
<td>6 yrs.</td>
<td>Exposure to cold</td>
<td>Left infra-orbital, occasionally supra-orbital</td>
<td>None</td>
<td>Various drugs, relieving temporary for 3 months ago</td>
<td>May 12th, 1889, Nevus twisted off at spheno-maxillary fissure from orbit</td>
<td>First intention</td>
<td>—</td>
<td>Blowing of Cure.</td>
</tr>
<tr>
<td>15</td>
<td>M., 65</td>
<td>32 yrs.</td>
<td>Exposure to cold</td>
<td>Left 2nd division</td>
<td>None</td>
<td>None</td>
<td>May 22, 1889, Removal of 2nd division</td>
<td>First intention</td>
<td>—</td>
<td>Marked emaciation. Complete cure.</td>
</tr>
</tbody>
</table>

* The letters a, b, and c signify second, third, and fourth operations respectively.
† At this operation a notable (pathological) bulging of the brain was observed when the skull was opened, and pressure thus relieved.
of the tentorium will be defined and the point at which the fifth nerve passes beneath it, in the first case I operated upon, be seen. The position of the canal in which the nerve is lying just above the ganglion must then be estimated, and a small puncturing incision made into it. As it is about a quarter of an inch in diameter, it can be recognised as soon as the puncturing instrument passes into it, and the dura forming its roof should then be further slit open. The nerve in this way is exposed, and is found to be freely lying in the little passage.

The first case on which I operated in this manner was the patient No. 5 in the table, in whom I had, as is shown there, previously removed a portion of the inferior dental and of the infra-orbital. The recurrence of pain, for which she then desired further operative relief, began in the auriculo-temporal nerve, the only branch remaining of the inferior division which had not been cut. As the pain, however, also ultimately invaded apparently the stump of the middle division, I thought it best to attempt the operation of dividing the nerve behind the ganglion. The patient had not eaten any solid food for several months, and was not in a good condition to undergo the operation. However, as her state was a very desperate one, I agreed to perform the operation, warning the friends that there might be fatal collapse even on the table. As a matter of fact, the operation presented no special difficulty beyond that of being very tedious. I resected the zygoma in order to have more room, but I feel sure now that that was a useless complication—that it was quite possible to have reached the nerve without it, and I regret having done it, because I think it of course aided in producing the shock which caused a fatal termination to the case. On opening the dura mater the brain bulged moderately into the opening, but as soon as the effect of the shock began to show itself it of course sank. On exposing the nerve in the canal behind the ganglion I passed a small blunt hook around it, and it then occurred to me that the small branch of the basilar artery which accompanies the nerve might give some trouble. I therefore thought one might safely attempt avulsion of the nerve from its attachment to the pons, and on gently drawing on it with a hook this was easily accomplished, and without even any noteworthy oozing. The wound was closed in the usual way. Unfortunately the patient never rallied from the operation, and died seven hours afterwards, obviously from shock.

At the post-mortem examination—which I obtained with some difficulty, and further details of which will be given in a paper on the pathology of the disease shortly to be published—I found that there was no cause of death except that already mentioned. There had been a slight amount of oozing into the subarachnoid space, but nothing to produce any compression at all, and of course of that there were no symptoms during life. At the moment when the fifth nerve was separated from the pons, although the patient was well under the anæsthetic, there was arrest of the respiration and the pulse could not be felt. This lasted for probably not more than three to four seconds, and then the respiratory movements and the pulse became normal. On reviewing the result of this operation I am satisfied that the unfavourable termination was due to the special circumstances of the case, and the considerable series of experiments on the lower animals which have been made involving the division of the fifth nerve show clearly that the mere exposure and section of the nerve is not of itself dangerous to life.
It has been proposed by Mr. Rose to remove the Gasserian ganglion by removing a ring of bone around the foramen rotundum. I have already shown that the ganglion cannot be wholly removed from its bed, but only a small portion. This operation therefore resolves itself practically into section of the branches of the lower two divisions of the nerve just within the skull. In Mr. Rose's first operation the foramen rotundum was reached by resecting the upper jaw. It is quite easy, however, to reach the parts by the Pancoast-Salzer method without resorting to this procedure, and, moreover, in Mr. Rose's case the eye was lost—a grave consequence, which is avoided by the method I carried out in 1886 of trephining the middle fossa through the pterygoid region.  

It may now be asked, do the results of the operation in those cases of invertebrate facial neuralgia justify the procedure? This question presupposes a previous one, namely, what is the condition for which the operation is undertaken? In other words, how is the operation supposed to act? Bell long ago suggested that section of the nerve in these cases produced an alterative and tonic effect on the nervous system. Erb agrees with Bell in thinking that the "strong peripheral stimulus of the operation is the cause of the disappearance of the neuralgia." Triepier regards facial neuralgia as probably due to some central change, and that a temporary inhibition is caused by the operation. Some cases, he thinks, may be peripheral, and may disappear if the irritant be removed. Wagner also believed that the mischief is central. Carbachan attaches great importance to Meckel's ganglion in the production of neuralgia, and an essential in his operation was the removal of this. And even with this idea as to the origin of the pain and the consequently less radical operations undertaken for its relief, the success has been so marked as to convince many surgeons of the usefulness of operative procedures. But I hold very strongly the opinion that epileptiform neuralgia is a purely peripheral malady, affecting principally the small subcutaneous branches of the nerve, or possibly the nerve endings, as well as the trunks of the fifth nerve, as they run in the bony canals of the facial bones, and that complete removal of the pain in any given division of the nerve may be obtained by ablation of the nerve from the base of the skull, unless the stump of the nerve become the seat of neuritis. (Vide Case 1 in the accompanying table.)

All other measures, for example, stretching, simple division, destruction of the nerve in a bony canal by the drill or trephining, may, and undoubtedly do, give relief for a varying period, but the disease is extremely likely to recur in the stump or trunk as soon as the paralyzing effects of the operation have passed off. I do not believe there is such a thing as reflection of pain along other branches, and certainly no proof of its existence is to hand, although it is freely spoken of as occurring. If pain is felt in two branches, for example, infraorbital and inferior dental, that means, I believe, disease of both those nerves. It is true that after operation on the nerve most affected, drugs such as gelsemium, etc., may so reduce the irritation in the other nerve as to render life tolerable and efficient, but in the end the remaining nerve, so far as I have seen, usually has to be extracted before permanent relief is obtained.

In this opinion I am supported by several authorities, and the evidence which they offer I shall discuss in a subsequent paper in the Practitioner on the pathology of this condition, in which I also hope to advance fresh evidence from cases of my own. Holding then as I do this opinion, I believe that operative procedure in those cases is an imperative duty when all medical measures of relief have failed. It is true that in many cases operation is not followed by that permanent relief which is aimed at, and this no doubt arises from several causes. One of these I believe to be the excision of too short a piece, permitting reunion of the cut ends. It is stated by Huter that experiments show that not less than 5 inches must be removed to prevent reunion with certainty. Although I am inclined to think that this is an excessive length, there seems to be little doubt that a considerable gap between the divided ends can be bridged over, but I am convinced that in many of the cases in which a return of pain after neurlectomy is ascribed to reunion, the result is in reality due to the occurrence of neuritis in the stump of the nerve, chiefly because the wound was not treated aseptically. Another reason for a want of permanent relief after neurlectomy is, I believe, because the nerve is not fully freed in the bony canal. If the neuritis does not frequently start in such a place, it is, I am sure, often very intense there, and the free removal of nerve in the canal, or the removal of bone so as to widen the aperture and prevent pressure, is essential. Then, too, if the neuralgia has persisted long, it is necessary to go far back, and a minor operation on the anterior portion of a nerve trunk may be followed by a recurrence of the pain trunk within a short time. I believe it is necessary to divide the nerve as near its origin as possible, so as to sever it where it is still healthy.

39 In Mr. Rose's second operation (vide Lancet, 1891) he employed the Pancoast-Salzer method and opened the foramen ovale.
40 Von Ziemsen's Cyclop., xi, p. 95.
42 Langenbeek's Archiv, vol. xi.
43 Grundriss der Chir., i, 144.
It is exceedingly difficult to get statistics as to the duration of relief after operations for this affection. Many cases are reported as cured after a few weeks or months, but there is nothing to show that the relief lasted even for a year. In many cases it is known to recur within that time, but I think that if the principles I have laid down are followed, recurrence will occur far less often than it has hitherto.

The occasions on which I have obtained what may be regarded as absolute cure or have observed recurrence of pain are grouped together in the accompanying table, which has been constructed so as to exhibit at a glance not merely the direct effect of the operation, but also the surgical details of the procedure, and the success or failure of the same.

The conclusions I would draw from this table are, that as soon as drugs and electricity have definitely proved unequal to the task of controlling the pain, the branch of nerve affected should be excised. The rapidity with which the wound heals and the absence of a noticeable scar deprive the procedure of obvious drawbacks, while the genuine nature of the relief it affords, in contrast to other methods, is shown by the fact that patients once operated upon will hardly wait to hear of other treatment if some other branch becomes affected.

INTRACRANIAL NEURECTOMY OF THE SECOND AND THIRD DIVISIONS OF THE FIFTH NERVE.

A NEW METHOD.†

By FRANK HARTLEY, M.D.

In my experience, Mr. President, one of the most difficult instances in which the surgeon is called upon to decide upon the feasibility of further operative interference exists in recurrences of pain following neurotomy or neurotomies for persistent neuralgia. It is not always possible to determine whether the seat of pain is situated beyond the seat of the previous operation, whether a new painful branch still uncut sends by irradiation the feeling of pain in the nerves operated on, or whether pressure or enlargement of the proximal end of the nerve is the cause of the recurrence.

With such uncertainty we can not be reasonably certain of a good prognosis until all branches of the trunk in which pain is present are cut.

In many of the operations for the relief of prosopalgia involving the second and third divisions of the fifth nerve, the difficult technique, the small field of operation, the arteries requiring ligature to preserve a clear field for the neuroectomy, are important considerations. Especially is this the case where previous neurotomy has been done in the field of the operation. The history of the case which I wish to present this evening is as follows:

J. D., aged forty-six years, married, England, salesman, admitted to Roosevelt Hospital on August 8, 1891. The patient's father died of pleurisy; in other respects his family history is negative.

Personal History.—Patient denies rheumatism and syphilis. He has had malarial disease, but in other respects has been perfectly healthy.

In December, 1888, he was seized with a sharp neuralgic pain, at first referred to a spot about two inches to the left of the symphysis menti. This pain radiated over the whole left side of the face and head, involving the temporal region as far as the temporal ridge, and the left side of the tongue and mouth over the upper and lower jaws. The left orbit was involved in this attack.

This attack lasted eighteen hours, and, after an interval of four days, during which time momentary attacks of pain were present in the same region, it reappeared. The second attack was more severe, and lasted two or three days. For the next two years he had constant pain over this region and was treated medicinally with aconitine and morphine.

In September, 1884, the infra-orbital nerve, with Meckel's ganglion, was removed.

From the scars left, one would judge that either Wagner's or Clavasse's operation was performed at this time.

For four or five weeks he had partial relief. The constant pain disappeared, but the spasmodic twichings continued. It soon reappeared, however, and the patient was again treated with aconitine and morphine.

He had at this time thirty-one teeth drawn, thinking that the origin of the pain was located in them.

After eighteen months (1886), section of the inferior dental nerve was made by the same surgeon. The scars would lead one to think that Velpes's operation was performed at this time.

On recovering from the ether he had an attack lasting seventeen days. From that time to the present he has had no change in his condition. The pain has been constant, except for an occasional period of one or two days. The contractions in the muscles of the face amount to forty in about thirty minutes.

Owing to the previous operations and the involvement of the lingual and auriculo-temporal nerves, I decided to attack the nerve at a point where I could divide the second and third divisions of the fifth nerve completely by one operation. The operation intended was to attack the nerve on the inner surface of the skull outside the dura mater, to isolate the second and third branches completely, to divide and resect as long a portion as possible. The advantages thought to exist in this method over Pancoast's, or its modifications by Krönlein, Credé, and Salzer, or Lücke's operation, were the easy access to the nerve, the comparatively large field for work, the rapidity with which the operation could be done, and the small amount of hemorrhage. The dis-
advantage was the inability to resect as long a piece as could be done in some of the other methods. This disadvantage I am certain can be overcome in the future when the knowledge of the degree of adhesion of the fifth nerve and dura mater is better appreciated. It is not difficult to go beyond the Gasserian ganglion.

This I did not appreciate fully before doing the operation on August 15, 1891. The operation performed was one in which an omega-shaped incision was made, having its base at the zygoma and measuring a distance marked by a line drawn from the external angular process of the frontal bone to the tragus of the ear.

The curved and rounded portion of this incision reached as high as the supratemporal ridge, the diameter of said circle being three inches. The skin and deeper tissues were cut in the shape of the Greek capital letter omega, a method of incision I first saw recommended by Uhle two or three years ago. This incision was carried down to the periosteum of the skull in all portions of the incision, except in the straight part at the base; the tissues were then retracted and the periosteum divided upon the bone in the same direction and as far as the straight part at the base.

With a chisel a groove was cut in the bone corresponding to the divided periosteum. This groove went to the vitreous plate, except at the upper angle over the rounded portion where it included the vitreous plate.

A periosteum elevator was here inserted and used as a lever to snap the bone on a line between the ends of the circular portion of the incision. In this way the breakage occurs along the lower portion of the wound, and a flap, consisting of skin, muscle, periosteum, and bone is thrown down, exposing the dura mater over a circular area of three inches in diameter. The middle meningeal artery was then tied, the dura mater was then separated from the bone, and the floor of the middle fossa of the skull was exposed. Broad retractors were used to raise the dura mater with the brain and to expose the foramen rotundum and the foramen ovale. The hemorraghe was stopped by sponge pressure. The exposure of the first, second, and third divisions of the fifth nerve, together with the carotid artery and cavernous sinus, was exceedingly good.

The second and third divisions were isolated at the foramen rotundum and the foramen ovale, and, by slight pressure upon the dura mater, it could be stripped from the nerves to beyond the Gasserian ganglion. These were divided with a tenotome at the foramen rotundum and the foramen ovale, and that part between these and a point beyond the Gasserian ganglion was excised. As this amount of nerve is not very great, the ends of the nerves were pushed through the two foramina so as, if possible, to interfere with any reunion. In the retraction of the dura mater, owing to imperfect instruments, the third, fourth, and sixth nerves were somewhat injured. As no bleeding was present, the brain was allowed to fill the fossa. The flap—consisting of bone, periosteum, muscle, and skin—was replaced. The irregular edge of the vitreous plate which remained attached to the bone not involved in the flap acted as a shelf on which the flap rested and prevented its falling in upon the dura mater. The periosteum was sutured, the muscle sutured in place, and the skin sewn with silk. One drainage-tube was inserted at the lower angle; an antiseptic dressing was applied. Time of operation, one hour and forty minutes; the patient was carried to the ward in good condition. Following the operation, August 16th, ptosis of the left upper lid appeared, together with double vision and inability to move the eye. The patient was entirely free from pain and continued to do well for one week.

August 23d.—To-day a slight dermatitis appeared over the area of operation, which is treated with ichthyl (ten per cent.) and bichloride irrigation.

On August 24th Dr. W. Vought examined the patient for me, and reported as follows: "The area of anesthesia may be seen upon the shaded portion of the drawing. The other areas were the left side of the mucous membrane of the mouth over the upper and lower jaws, of the soft palate, of the anterior two thirds of the left side of the tongue, of the left conjunctiva and cornea, and of the left nostril. Muscular paralysis, complete, of the left buccinator, the pterygoids, and the left orbito-frontalis (frontal portion); almost complete, of all the external muscles of the eye. Ptosis; pupil normal. Nerves divided: the second and third divisions of the fifth nerve, the branch of the seventh to the orbito-frontalis; injured, the third, fourth, and sixth nerves. The opthalmoplegia externa I should give a fair prognosis for spontaneous recovery, as you will see by examining the patient that slight movement of all the eye muscles is present, which leads me to think the nerves have not been divided, but merely severely injured. The ptosis could be corrected at any time."

August 30th.—Patient is to-day discharged cured and returned to the Vanderbilt Clinic, Nervous Department.

September 30th.—Patient has recovered from his paresis in the third nerve; the double vision, ptosis, and inability to use the third nerve have entirely disappeared. The paralysis of the pterygoid, temporal, and masseter muscles produced by the division of the motor portion of the fifth seems to have incommoded him to a very slight extent. The false teeth worn in the lower jaw before the operation fit quite accurately their opponents in the upper. Protraction and retraction of the lower jaw seem to be diminished, but elevation and depression of the lower jaw seem good. As the patient has
chewed since 1882 all his food on the side opposite to the present paralysis, he has not been distressed by the division of the motor portion of the fifth.

The patient informs me that he is at present entirely free from pain and has gained in weight sixteen pounds.

I wish to say in conclusion that this method of reaching the base of the skull I have employed in the posterior fossa in a case of suppurative meningitis following otitis media. Though the case had a fatal issue, the exposure of the posterior fossa was good.

January 13, 1892.

Excision of the Gasserian Ganglion and of the Trigeminal Trunk Situated Centrally from It*1

By Fedor Krause

Last year I was able to present to you a report concerning a new procedure, which in incurable cases of trigeminal neuralgia, when surgery has already been performed on the peripheral branches extracranially without any lasting effect, makes it possible to expose the nerves within the cranium itself and to resect them there. In the meantime I had to perform surgery in two additional cases and I was planning on presenting these two patients to you. But since the date of the lecture was postponed for two weeks, and one of the patients has returned to his home, I can only show you the pictures and give you his case history. The last case is the most difficult and most interesting and for this reason I shall present it.

Case 1. It concerns a woman of 68 years, Mrs. R. from Hamburg, with no history of previous illness. In the summer of 1873, she felt pains for the first time in the left side of her face, but these pains quickly subsided. Soon the pains returned in severe form and persisted for a longer period of time. Since the pain was getting more acute and all internal medicines were useless, in November 1880, the alveolar nerve was resected. At the first operation had a successful result, but within a year the pains reappeared in their old severity and in 1883 the third branch of the trigeminus at the base of the cranium had to be resected. This operation had no effect. From that time on, the attacks of pain were continuously more severe and often persisted for days and weeks, followed by tolerable intervals. But in the last year the painfulness increased still further and since in addition the patient greatly overtaxed her weakened strength in caring for her husband who was ill with cholera, her condition was aggravated and the severe pains persisted without cessation from September 1892. The afflicted woman suffered continuously from insomnia, her nutrition was very poor, because pains made chewing impossible and for days she did not leave her bed because of weakness. This condition explains why the patient had suicidal thoughts.

When I saw her for the first time on January 24th of this year, I did not at first have the impression that this was a case of trigeminal neuralgia. Rather, the unbearable severe pains, according to the report of the patient, affected quite uniformly the entire left side of the face and head and radiated even in the nape and neck. The trigeminal branches were hardly more sensitive to touch than the greatly hyperesthetic skin of the face and head. Only the past history and the definite information of the family doctor, that the suffering began years ago as neuralgia in the third branch, provided a hope that repeated surgery might help the patient.

Nothing could be expected from other medications, as the family doctor had used the most varied internal medicines for years without any appreciable success. Since the third branch had been resected by a renowned surgeon, first in the individual branches with a temporary success, and later in toto at the base of the cranium without any success, only the intracranial procedure reported by me could be considered.

For the following reasons I decided in this case to extirpate the gasserian ganglion and the trigeminal trunk itself: first, the third branch is functionally the most important; beside the sensory branches to the skin it also has the lingual nerve and supplies the musculature of the lower jaw; but the functions of this branch had already been destroyed in the case of my patient, by previous operations. In addition, as mentioned above, the pains were distributed so regularly over all the trigeminal branches and even far out in the surrounding area that no definite successful results could be expected from the intracranial resection of the third branch itself, even though it was justified to consider some of the pains as radiating and based on radiation. When operating on my first patient more than a year ago, I was able to determine that the direct resection of the second trigeminal branch at the gasserian ganglion was not followed by even a slight disturbance in the nutrition of the eye or any inflammation. Finally, as far as the first branch is concerned, it is the least significant with regard to its physiological functions. Therefore in the case of this patient I considered the removal of the entire trigeminus completely justified and surgery was performed on January 31 of this year.

While in my first two cases, both involving the removal of the affected second branch only, I divided the operation into two stages, so that bleeding in the depth of the middle cranial fossa would not obstruct my view, in this case I de-
cided to perform the operation at one time, because I did not wish to expose the old lady, who had been weakened by severe pains for years, to the danger of narcosis and surgical intervention twice in quick succession. In addition, in the two previous operations I learned that when the brain is in the closed dural sac, it tolerates an upward displacement very well, and no disturbances of its function can be detected later. This finding was of great importance with regard to the left side, since the important speech centers are situated in the posterior section of the third frontal convolution and in the first temporal convolution. As the brain must be displaced upward during surgery, exactly in this region, and even in the most careful procedure a certain pressure from below cannot be avoided, only experience could provide in this respect the information concerning the harmlessness of surgical intervention.

Furthermore, I already stated in my first report that it necessarily makes an essential difference, whether the brain is displaced upward in its protective casing, the closed strong dural sac, or whether—as Victor Horsley* has done in one case in order to sever the trigeminal trunk behind the ganglion—the dura mater is removed in the entire area of the trephined opening and the exposed brain is lifted with a spatulated instrument. The pressure—even if very small—that the spatula must necessarily exert, is distributed in my procedure on a larger area and thus reduced, while the exposed brain is pressed only at the place corresponding to the width of the spatula. The patient of Horsley did not recover from operation but died in shock seven hours after the operation, while my three patients—two women, 47 and 68 years old, and a man, 64 years old—recovered and did not present any cerebral symptoms. My first case of operation concerned a right-sided neuralgia, the second case the left trigeminal; the course after these operations showed to me again that, as in the first case, no injuries with respect to the functions of the brain took place. Therefore, on the basis of these experiences, I was able to proceed in the last operation more rapidly with the detachment of the dura and elevation of the brain, than in my first two cases, in which I had to proceed more cautiously.

I tried to shorten the operation also in another respect, in order to be able to finish it at one time. In my first cases, in accordance with the Wagner-Wolf procedure, I left the bones united with the soft parts, i.e. formed a flap consisting of skin, muscle, periosteum and bone. Since the dura mater must not be injured, the chiseling must be very careful; that takes time. Therefore in my last case, because the patient was in very poor condition, I did not retain the bone, in order to spare time. The flap incision visible in Fig. 3 was made directly to the bone, then the periosteum in the entire area of the flap was torn off with the raspatory and bleeding was checked. Then I chiseled a hole in the skull in the center of the very thin squamous portion of the temporal bone, just large enough to be able to insert Luer’s gouge forceps, and with them broke off the skull capsule in the entire area of the flap. As is known, this can be accomplished in a very short time. Then I advanced, not very slowly as in my first operation, but relatively quickly, with the blunt raspatory between the hard cerebral meninges and the upper surface of the base of the skull in the middle cranial fossa, and when I had enough room I used the raspatory and my finger alternately, until the trunk of the meningeal artery and the third and second branch of the trigeminal were visible in their entire lengths up to the gasserian ganglion. In addition, I was gratified to find that in this quick detachment of the dura mater from the bone, the bleeding was less extensive than with a slow procedure.

This part of the operation, starting from the first cut, did not last more than twelve minutes; therefore, I was able to proceed at once to the clearing of the second and third branch and the gasserian ganglion, after I pushed the brain in the closed dural sac upward with the spatulated instrument.

However, since the trunk of the median meningeal artery in this procedure is almost in front of the third trigeminal branch, i.e., it obstructs further work, I ligated it at two places and cut it between the ligatures. As evident from this, my procedure is also very suitable for ligation of the trunk of the median meningeal artery in cases of bleeding. Before proceeding further I checked the massive bleeding by pressure application of sponges.

Subsequently, first the third, and then the second branch situated farther medially, were exposed for their entire length from the gasserian ganglion to the foramina ovale and rotundum, with the elevator, i.e., the dura mater was pushed back from the nerves, and then it was detached from the underlying bone. The same was then tried with the gasserian ganglion. This attempt was completely successful. I wish to emphasize this fact, since in my first work on the basis of postmortem studies I maintained that the dura mater could be retracted only from the convex anterior margin of the ganglion, from which the three trigeminal branches project, and from the adjoining section, while in the upper section of the ganglion the dura was presumably so

closely fused with it that it could not be retracted with a blunt instrument. Additional postmortem findings showed me that this statement is not valid in such exclusiveness; rather, when some individual thin, but unusually strong bands of connective tissue are cut with scissors, the dura can be pushed back from the ganglion with a blunt instrument. The dural sac is not opened. In the case of the patient, the dura could be detached in this manner with the elevator without any difficulty in the entire length of the ganglion and retracted so far back that the trunk of the trigeminus could be seen. Finally, the ganglion was detached from the underlying bone. Now both the ganglion and the second and the third branches were completely exposed.

I intentionally exposed the first trigeminal branch only in the immediate proximity of the ganglion and no farther, for it extends in the wall of the cavernous sinus and although I verified in postmortem findings that it can be retracted from the latter, it must be kept in mind that the trochlear, abducens and, farther centrally, the oculomotor nerves are situated in its immediate proximity; and it is imperative that an injury or even laceration or bruising of these nerves be avoided. How easily such a lesion can be produced when the procedure is not done with extreme care, is evident from a communication of Frank Hartley,* who performed the operation in the manner described. He resected the second and third trigeminal branches intracranially in the case of a 46-year-old man, who had already undergone repeated surgery without any lasting effect. As Hartley himself stated, during the retraction of the dura mater the oculomotor, trochlear and abducens nerves were apparently injured. ("In the retraction of the dura mater, owing to imperfect instruments, the third, fourth and sixth nerves were somewhat injured.") As a result, the patient had ptosis, double vision and inability to move the eye. Accurate examination nine days after operation revealed very weak movements of all muscles of the eye; consequently, the nerves could not have been cut. Six weeks later, the oculomotor nerve was again functioning; no special mention was made of the trochlear and abducens nerves, only a statement that the double vision disappeared.

I did not encounter a similar misfortune in my three cases and I believe that with a careful deep dissection it is completely avoidable. The wound can be surveyed easily, as shown in Fig. 1. In addition, an electric lamp is not needed for illuminating the deep-lying area. This is also evident from Fig. 1; if photography is possible under far worse lighting conditions of a morgue, the cavity of the wound would necessarily be easily visible in the operating room.

Since the illustration in my first report, which was made by a draftsman, who was not too proficient, did not give the correct relations, I performed the operation postmortem and photographed the preparation—with a very narrow lens opening and an exposure time of three minutes in order to show correctly the great depth of the wound in the picture. Consequently, the retractors could not be held, but were affixed to the head of the corpse itself by strings. A stereoscopic picture was passed around during the lecture, which demonstrates the spatial dimensions of the operative field far better, of course, than the simple photograph.

From the time of Thiersch's procedure we have been striving to accomplish the removal of the nerves in neuralgia to the greatest possible extent, and therefore I wanted to draw out in this case the peripheral branches with Thiersch's forceps, but did not succeed. This is understandable in the case of the third branch, because it had previously been resected in the periphery and held fast here by scar tissue. But the second branch also threatened to break off during the very careful rotating of the forceps, whereas normally, the ramifications of the peripheral nerves can be untwisted without any difficulty. Therefore I discontinued this maneuver and cut the two branches in the foramen ovale and rotundum as deep as possible with a sharp tenotome. Then I grasped the whole gasserian ganglion transversely in the Thiersch forceps and with a rotating motion pulled out the centrally (i.e., posteriorly, toward the pons varolii) situated trigeminal trunk in its entire length of 22 mm. This procedure was performed in deep narcosis and no visible change could be observed either with regard to cardiac activity or respiration. After the trigeminal trunk was cut, Horsley* observed the cessation of breathing and disappearance of pulse; these disturbances lasted three to four seconds and then normal conditions returned. During the removal of the ganglion the first trigeminal branch close to the ganglion also broke off, and I did not have to cut it. Fig. 2, taken immediately after the operation, of the removed nerve sections in natural size, shows that the entire trunk of the trigeminal was removed up to its exit from the pons varolii. In addition to the photograph I am going to show you also the preparation hardened in osmic acid, from which only small pieces were removed for microscopic examination. The report of the histological findings will be given elsewhere.

The operation performed in this manner lasted no more than 55 minutes from the first skin incision to the completion of the nerve resection. The flap of skin, muscle, and periosteum was attached with interrupted sutures in its old place. A small strip of 10% iodoform gauze was placed between the dura mater and the base of the skull to guide out the oozing blood; it was removed the third day.

The course was completely undisturbed; in the evening after the operation the neuralgic pains had already gone and did not return in the nine weeks that have passed since that time. On the seventh day after operation, the patient felt strong enough to leave her bed for some time. Eighteen days after operation the patient returned to her home. The general condition, which because of the long suffering was so extremely poor, improved quickly and nervousness and insomnia also disappeared.

Dr. Nonne examined closely the important conditions in the area of the resected trigeminal on four different days (February 25 and 27 and March 2 and 6) and sent me the following report, which I greatly appreciate; [See Fig. 8.]

*In area a, complete anesthesia for all stimuli; at b, sensitivity to all stimuli greatly reduced; at c, less extensively, but still very considerably reduced for all stimuli; at d and e, strong contacts were felt clearly—strong stimuli of pain (electric current, deep stabbing, etc.), felt as pain; at f, only slight reduction of the sensitivity to all stimuli.

"At any place where the sensitivity is only reduced, but not completely abolished, the ability to localize the tactile impressions is, however, very strongly reduced."

"The ear has completely normal sensitivity (N.

* i.e.
auricularis magnus, even the trigeminal part, has intact sensitivity.

"Hearing: left slightly less than right.

"Smell: left = right.

"Taste: (sweet, sour, bitter, galvanic current) on the left—clearly present, but reduced. Sensitivity of the tongue (pricking, electric stimulus, heat, cold) on the left, weaker than on the right.

"Masticatory muscles: (temporals, masseter) no action observed on the left. Degenerative reaction in masseter is not demonstrated.

"Bulbar and palpebral conjunctiva, as well as cornea, completely insensitive. Cornea completely clear, no conjunctivitis or keratitis. Movements of the eye, normal; sight as before.

"Sensitivity of the labial and buccal mucous membrane completely abolished on the left side.

"Vasomotor abnormalities of the skin of the face are absent, as well as trophic disorders of skin (glossy skin, etc.).

"In each of the four examinations an improvement of the sensitivity was observed."

In addition, I believe that I should emphasize that no ulcerative formations or trophic changes were found either on the tongue or the mucous membrane. If the patient happens to bite into her left side while chewing, she does not feel the bite. The movements of the jaw are completely free and she can again tolerate dentures, which in the first weeks produced unpleasant sensations.

The left eye no longer secretes more or less tears than the right one, and the nasal mucous membrane of the left side—except for anesthesia—does not differ in any way from the right side.

Unfortunately, it was not possible to perform an accurate examination of the nervous condition before operation; it would have been torture for the patient in her wretched condition and would not have provided any useful results.

Finally, as far as the formation of the flap in this case is concerned, I did not see any disadvantage resulting from the removal of the bone; anyhow, previously in each such trepanation, we were generally accustomed to break it. But in this case the dura mater was retained and the periosteum was supported by the muscular cushion. Brain pulsations are neither felt nor seen and the palpation of the upper part of the flap makes it highly probable that a new bone formed from the detached periosteum; the thick soft parts prevent us from determining this in the lower section of the flap. Nevertheless, in further cases, which would not require that the time of operation be limited as much as possible, I would prefer to
retain the bone and include it together with the soft parts in the flap.

Case 2. Mr. C. Morris, aged 64, government employee from Washington, afflicted for 13 years with neuralgia in the region of the second trigeminal branch, in 1884 was operated on successfully by Agnew in Philadelphia with Langenbeck’s method. But only a year later pains returned in their former severity. A new operation with partial removal of the upper jaw was performed in Washington, but without favorable outcome. In the spring of 1886 several surgeons were consulted even in Germany; they refused to do further operation. Injections in the lips, which were administered in Vienna, alleviated pains for some time. In recent years pains became more severe than before and in this condition the patient turned to me. It was a case of typical neuralgia of the second trigeminal branch of the left side; pains appeared three to four times a day and always lasted two hours. The attacks came only rarely at night.

The operation was performed on December 3 and 8, 1892, in two stages, in exactly the same manner as was described in my first report. The second trigeminal branch was excised from the gasserian ganglion to the foramen rotundum. In the first days after the second operation pains continued with diminished severity, then ceased and had not returned up to the day of his departure (March 8, 1893).