TRACTOTOMY FOR THE RELIEF OF TRIGEMINAL NEURALGIA

OBSERVATIONS IN 124 CASES

BENIAMINO GUIDETTI, M.D.
Neurosurgical Clinic, Serafimerlasaretet, Stockholm, Sweden

(Received for publication February 25, 1930)

ONE of the chief objections to section of the 5th cranial nerve, according to Frazier, is the resulting total loss of sensation in the trigeminal area which, though tolerated by most patients, is always an unpleasant sequel. In some instances the operation has resulted in painful paresthesias in the anesthetic area.

To eliminate these complications Sjöqvist, in 1937, as an outcome of his anatomical study of the trigeminal root, performed the first operative sectioning of the descending tract of the trigeminal nerve in the medulla oblongata, and obtained a dissociated anesthesia.

Since 1937 approximately 284 cases of tractotomy for various neuralgic syndromes have been reported from several different clinics. From the extensive material in Olivecrona's clinic I believe it is justifiable to draw conclusions regarding the indications for and against this method.

CLINICAL MATERIAL

During the years 1937 to 1948, 124 patients suffering from major trigeminal neuralgia have been operated upon at Serafimerlasaretet (in this series cases of bilateral neuralgia have not been included).

The patients might be divided into two groups, according to the level at which section of the trigeminal tract was performed: (Group 1) Those patients, a total of 40, in whom the tractotomy was performed at a level corresponding to the border between the middle and the inferior third of the olivary eminence, as originally recommended by Sjöqvist. These cases were reported on fully by Olivecrona in 1942.

(Group 2) The 84 patients (1940–1948) in whom the tractotomy was performed at the level of the obex or, in a few cases, caudal to it. This modification of Sjöqvist's original technique was dictated by the conviction that most of the symptoms following tractotomy by his method were due to injury of the restiform body and the vagus rootlets. (Weinberger and Grant are given credit for being the first to carry out this modified technique, but unfortunately their paper was not available in Sweden during the war.)

At the level of the obex, or a few mm. caudal, the trigeminal tract emerges from under the restiform body, and appears on the external surface of the medulla oblongata, forming at this point, between the posterior and lateral areas, a more or less pronounced elevation, called the tuberculum

* Chief: Professor H. Olivecrona.
cinereum. The tuberculum cinereum, as pointed out by Gonzalez,1 is not always situated at the same level. Its position in the medulla oblongata varies not only in different individuals, but also in the two sides of the same individual. As a rule, however, it is pronounced a few mm. caudal to the level of the obex. Root section at this level, therefore, the spinal tract of the trigeminal nerve being no longer covered by the restiform body and the lowest rootlets of the vagus nerve having left the medulla rostral to this level, should not be followed by these complications.

OPERATIVE TECHNIQUE

The operative technique is the same as that described by Olivecrona in 1942.6

Even today a local anesthesia is preferred, because the pain experienced by the patient and the ensuing analgesia assist the surgeon to regulate the extent and depth of the incision.

The incision should be made at a level corresponding to the lower end of the 4th ventricle, or 1 to 2 mm. caudal to it, immediately lateral to the funiculus cuneatus, and extended ventrally to a point just dorsal to the level of the vagus rootlets. To ascertain the exact position of the sensory fibers of the 5th cranial nerve, it is a good plan to feel gently over the probable area with a blunt dissector. Location of the nerve will give pain in the corresponding side of the face. At the moment of incision, if it has been correctly placed, the patient will feel pain in the whole trigeminal area. If pain is felt only in the ophthalmic area, the incision should be extended a little in the dorsal direction. If pain is felt only in the mandibular area, the incision needs to be extended slightly in the ventral direction. To confirm that the incision has been correctly placed the sensation in the face is tested.

Great care must be taken to make the incision no deeper than 2 to 3 mm. in order to prevent damage to the ambiguous nucleus and sympathetic fibers. If the incision is extended too far in a dorsal direction the posterior columns and their nuclei may be damaged. If it is extended too far in a ventral direction, the spinothalamic and spinocerebellar (ventral) tract may be injured.

For neuralgia localized in the 3rd division, section of the trigeminal tract at the level of the obex does not always have the desired effect. If a cautious extension of the incision in a dorsal direction does not give complete analgesia, a new incision should be made slightly rostral to the first one.

OPERATIVE MORTALITY

In this series there have been 2 operative deaths (1.6 per cent). One patient died from pulmonary edema and a postoperative clot in the posterior fossa. The other patient died from a clot in the cerebellopontine cistern caused by bleeding from the tractotomy incision.

Autopsies were performed in each case.
TRACTOTOMY FOR RELIEF OF TRIGEMINAL NEURALGIA

RESULTS

Tractotomy was followed by loss or diminution of the sense of pain and temperature in the whole or part of the affected side of the face. The analgesia and thermoanesthesia were usually more marked during the early postoperative period than at a later stage, and as a rule went together. If there was complete thermoanesthesia, the patients were unable to discriminate between hot and cold water. Some patients had considerable impairment of their perception of pain, and others of their perception of heat, or cold, or both. These are not new or unexpected observations. Spiller long ago emphasized this dissociation, which he noticed in a case of thrombosis of the posterior inferior cerebellar artery, from which he concluded that there must be separate pathways for the perception of pain and temperature sensibility in the trigeminal tract.

The sense of touch was well preserved when tested with cotton wool or the finger tip. In some cases, however, there was slight subjective impairment, which corresponds to the observation made by Grant and his co-workers that sometimes the number of touch points per square cm. was reduced and occasionally the threshold for touch points was increased. The majority of patients, however, noticed no diminution of facial sensibility after the tractotomy, except a slight difference between the two sides of the face when they ran their hands over the face, or when shaving.

Like practically all other writers on this subject, I found the ophthalmic division the most uniformly denervated, and the mandibular division the least denervated. In 85 patients, however, there was diminution or loss of pain and temperature sensibility in the mandibular division, which demonstrates that an analgesia of the 3rd division can be obtained more easily than is commonly thought possible. I shall refer to this again later on.

IMMEDIATE AND LATE NEUROLOGIC DISTURBANCES

Headache. In most instances the patients complained of severe headache for a few days after the operation, due undoubtedly to the loss of cerebrospinal fluid, and to penetration of air into the subarachnoid space.

Cerebellar Disturbances. During the first days following the operation, a high percentage (33 per cent) of the patients complained of cerebellar disturbances: incoordination of the arm and, less frequently, the leg on the side of the operation; weakness of the body on the affected side; disturbance of equilibrium with a tendency to fall on the side of operation; vertigo; and in some cases dysmetria of the arm, and nystagmus. Some of these patients, during the first weeks after operation, were obliged to use a support for walking.

As a rule these disturbances disappeared within a few weeks. Some patients found a certain difficulty in riding a bicycle, and walking in the dark, which persisted for some years. Only in 14 patients did slight disturbance in equilibrium persist for several months. (One patient, No. 25, earlier re-
ported on by Olivecrona, and in whom the operation was complicated by hemorrhage causing a hematoma in the posterior fossa, was still unable to walk without support 5 years after operation.

These complications are probably due to injury to the restiform body, because they usually occurred in cases in which section of the trigeminal tract was performed at a level rostral to the obex, at which level the trigeminal fibers are still covered by the restiform body. Out of the 40 patients in this series in whom the tractotomy was performed from 2 to 6 mm. rostral to the obex, 27 (67.5 per cent) complained of these disturbances. In 14 patients the disturbances disappeared within a few weeks, in 12 they persisted for several months, and in 1 for 5 years (the case mentioned earlier).

Of the 84 patients in whom the tractotomy was performed at a level corresponding to the lower end of the 4th ventricle, or caudal to it, these disturbances occurred in only 14 (19 per cent), in 13 disappearing within a few weeks, and in 1 persisting for several months.

According to Sjöqvist, these complications occur more frequently in older subjects than in younger. In our series I controlled this observation, and found the average age of patients who exhibited these disturbances to be 54, and of those who had no postoperative complications, 48.

Ataxia. Ataxia of the arm on the side of operation was observed in 3 patients. As it was connected with decrease of the sense of touch, and impairment of the sense of discrimination and position, it was believed that the nucleus of Burdach had been injured. This complication was noticed in a further 2 patients, but an accurate examination of the sensibilities could not be made.

Ataxia occurred more frequently in cases in which the incision had been made at the level of the obex, than in cases in which it had been made somewhat rostral. This complication is to be dreaded, especially when the neuralgia involves the 3rd division, in which case extending the incision too much in a dorsal direction can cause damage to the nucleus of Burdach.

Recurrent Nerve Paresis. This complication on the side of operation occurred in 8 patients; in 4 it was severe, and in 4 comparatively slight. In 6 of them the tractotomy was performed at the level rostral to the obex, in 1 at the level of the obex (slight paresis), and in 1 (severe paresis) at a level 2 mm. caudal.

In my opinion the most frequent cause of this complication is injury to the vagus rootlets at the level at which they pass through the spinal trigeminal tract. i.e., the middle of the olivary eminence. In the majority of patients with this complication the tractotomy had been performed at a level between the middle and inferior third of the olivary eminence. A too deep incision, injuring the nucleus ambiguus, may certainly be the cause of a recurrent nerve paresis, but, as the nucleus ambiguus runs through the length of the medulla oblongata, injury to a small group of its cells should not result in any lasting disability.

Another mechanism which might be of importance, and probably was
the cause in the last case in the series, is the traction that might sometimes unwittingly be placed on the vagal roots at their point of exit from the medulla.

_Horner's Syndrome._ This complication was more or less complete in 6 patients, due to injury of the descending sympathetic fibers where they run in the reticulated substance, indicating that the incision had been made too deep. In most instances it disappeared within a short time, leaving no ill effects.

_Corneal Complications._ Although the corneal reflex was lost or diminished in the majority of the cases, slight neuroparalytic keratitis occurred in only 2, and was then due to the patients' own carelessness. This shows that the neuroparalytic keratitis, which is a frequent sequel of trigeminal tractotomy according to Frazier, is not caused by loss of the corneal reflex, but is most probably due to injury of the superficial petrosus nerve and the gasserian and perigasserian sympathetic fibers.

_Lesions of the Spinothalamic Tract._ In 10 patients the fibers of the spinothalamic tract were damaged, resulting in analgesia and thermoanesthesia of a more or less extensive area on the contralateral side of the body. This complication occurred more frequently in patients with neuralgia involving also, or exclusively, the ophthalmic area. This is due to the fact that the fibers of the 1st division run in the ventral part of the trigeminal tract, and an attempt to divide them can easily damage the spinothalamic tract, which at this level runs between the nuclei of the 5th cranial nerve and the inferior bulbaris oliva. In 7 of the patients the tractotomy was performed at the level of the obex, in 2 patients rostral to it, and in 1, caudal.

In 5 patients the postoperative analgesia and thermoanesthesia were limited to the foot and leg on the contralateral side; in 1 patient to the foot only; and in 1 patient reached up as far as the 12th dorsal segment. In 1 patient there was only analgesia in the contralateral foot and leg, while the temperature sensibility remained normal. In another it was noticed that whereas the analgesia reached to the 12th dorsal segment, the thermoanesthesia reached to the 3rd dorsal. Another case is worthy of mention:

Case 67-670/44. A man, aged 58, had had attacks of major trigeminal neuralgia in the 1st and 2nd divisions of the nerve for 2 years. Neurologic examination revealed nothing abnormal. As the neuralgia was principally in the 1st division of the 5th cranial nerve, it was decided to do a tractotomy. This was performed at the level of the obex. Tests after the operation showed that there were analgesia and thermoanesthesia within the region of the 1st and 2nd divisions, while in the area of the 3rd division all forms of sensation were normal. On the contralateral side of the body there was decided diminution in the sense of touch, pain and temperature as far as the 3rd cervical segment.

Three months after operation painful paresthesias developed in this area—excluding the face—which were described by the patient as a burning sensation. These paresthesias were not spontaneous, but were provoked usually by pressure on the affected side, as when sitting or getting into bed. They started as a burning pain, and spread over the entire half of the body up to the 3rd cervical segment,
without crossing over the midline. The same thing occurred if pressure was applied to the skin. Five years after operation these disturbances are still present.

On the whole, the loss of sensibilities and the slight paresthesias were well tolerated, and did not impair the working capacity, except in the aforementioned case, and in 2 others with slight paresthesias in the foot, on the contralateral side.

From these accidental lesions it might be argued, and rightly so, that the spinothalamic tract, at the level of the medulla oblongata, has the same arrangement as in the high cervical segments. The dorsal external fibers carry impulses from the caudal segments of the body; slightly deeper and medially, run the fibers carrying impulses from the lumbar and thoracic segments of the spinal cord; and centrally and ventrally, fibers carrying impulses from the cervical segment.

Spiller's observation that the sensibilities are not confused in the spinothalamic tract appears to be confirmed in the 2 cases mentioned earlier.

On the other hand, observations made in 1 patient with analgesia up to the 12th dorsal segment, and thermoanesthesia up to the 3rd dorsal, support the concept that the fibers carrying temperature sensibilities run in the posterior part of the spinothalamic tract. This agrees with the findings of Stookey and others that chordotomy did not always abolish the temperature sensibility since its fibers lie in the more dorsal part of the tract.

Postoperative Paresthesias. Theoretically there is no reason why dysesthesia should not follow division of the descending tract of the trigeminal nerve, because it is well known that thrombosis of the posterior inferior cerebellar artery is frequently followed by severe painful paresthesias.

Eight patients complained of paresthesias, but in all 8 they were mild, not in any way comparable with the severe forms found after root section according to Frazier. Most of the patients felt "soreness" around the eyes, together with a slight burning sensation.

Recurrence. One of the most important points to be considered when evaluating the results of tractotomy, is the frequency of recurrence.

There were altogether 46 cases (37.1 per cent) of recurrence. Of the 27 patients in whom the recurring pain was severe, 14 had to be operated upon according to Frazier, and 1 according to Dandy. In 3 cases in which the first operation was a complete failure, with no analgesia and return of the pain, a secondary operation was performed immediately. The wound was reopened, and the incision into the medulla deepened. Two of these patients had recurrence of pain; in 1 it was slight, and in the other severe. Nine of the patients who had a severe recurrence of their pain did not wish to submit themselves to a further operation.

Among the remaining patients with recurrence, there were 5 in whom the recurring pain was mild, and 14 in whom it was slight. All of them can be said to have benefited from the operation.

It must be borne in mind that there is a risk of recurrence even after several years, depending on the degree of analgesia obtained. If complete
analgesia is not obtained in severe cases of neuralgia, the recurrent pain is likely to be as severe as the original pain, although sometimes (in 5 cases in this series) even complete analgesia of the trigeminal area is not a guarantee against recurrence.

In my opinion, from the point of view of recurrence, there is not much difference between those with mild, and those with severe forms of trigeminal neuralgia, though it might be thought that recurrence is more frequent in cases with severe neuralgia. Thirty patients in whom the trigeminal neuralgia had been severe, and 41 in whom it had been mild, had no recurrence of pain several years after the operation. Of the patients who had recurrence, 27 had had severe neuralgia, and 19 mild.

Furthermore, I did not find that the level at which the spinal trigeminal tract was severed, whether the obex, or caudal to it, in any way affected the recurrence.

In those patients with neuralgia involving also the mandibular area, the results of the operation as regards analgesia and recurrence were good in 20 patients, and poor in 10.

In those cases in which the neuralgia was localized exclusively in the 3rd trigeminal division, the operation gave good results in 5, and poor in 3.

In spite of these results, which do not really differ from those obtained in cases of trigeminal neuralgia localized in the 1st and 2nd division, I am of the opinion that for cases of neuralgia localized principally or exclusively in the mandibular area, tractotomy is not the method of choice. This is not because it is difficult to obtain analgesia in the 3rd trigeminal division, but because the operation is potentially more dangerous, the fibers of the 3rd division being situated in the dorsal part of the tract in the neighborhood of the dorsal nuclei. Furthermore, it is not always possible to get complete analgesia of the 3rd division by section of the trigeminal tract at the level of the obex. This would then necessitate section at a somewhat rostral level, resulting in unavoidable damage to the fibers of the restiform body.

**DISCUSSION**

To evaluate the therapeutic effect of any operation a long period of observation extended over many years is necessary, and a careful consideration of the risks involved compared with the advantages obtained.

Major trigeminal neuralgia is an extremely painful, but not fatal disease. To alleviate this condition, a surgical intervention is necessary which, with the lowest mortality rate, will relieve the pain without leaving disturbances that are more intolerable than the original pain.

Three surgical measures are used:

1. Subtemporal section of the sensory root (Frazier).
2. Suboccipital root section (Dandy).
3. Intramedullary section of the descending tract of the trigeminal root (Sjögqvist).

The transtemporal approach is very safe. In a series of 515 patients
operated upon in this clinic up to Dec. 31, 1948, the operative mortality was 0.77 per cent. This figure is very low when one considers the ages of these patients: 43 were over 75, 71 over 70, 87 over 65, 102 over 60. Among the 515 patients are included 25 operated upon for recurrence of pain. In the last 360 operations performed in this series, there was only 1 fatality.

Complications that may follow section of the 5th cranial nerve through the temporal fossa are facial weakness, keratitis, and paresthesias. Facial weakness and keratitis can, in the great majority of cases, be easily avoided. The only serious objection, therefore, to section of the trigeminal roots according to the Frazier method is the disability and discomfort caused by complete or nearly complete anesthesia in the greater part of the trigeminal area, and the paresthesias which sometimes occur in the same area.

Of the patients operated upon according to the Frazier method, the records show that 56 complained of slight paresthesias, and 16 of severe, continuous, burning paresthesias in the anesthetic area of the face. In these latter the former intermittent trigeminal pain disappeared after the operation, but was replaced by constant, intense paresthesias in the same anesthetic area, which were more distressing than the original spasmodic pain.

A preventive peripheric alcoholization, advised by many authors, to get patients used to the residual anesthesia, is not a guarantee against these complications. In some patients in whom a preventive alcoholization was done in other clinics without resulting in painful paresthesias, section of the sensory roots according to the Frazier method was followed by paresthesias in the anesthetic area of the face. These complications, at one time intractable, can today be overcome by the operation of lobotomy. (Of 3 patients in whom lobotomy was performed, 1 died after a few days from double pneumonia. In 1 patient the results were excellent, and in 1 they were good.)

The low rate of mortality, the infrequency of recurrence (theoretically there should be no recurrences after the temporal operation, but the 8.3 percentage of recurrences shows that the surgeon has been too conservative in a number of cases), the short period of hospitalization, and the insignificant number of complications, make section of the trigeminal sensory roots according to the Frazier method one of the surest and simplest methods of operation today. It is still the operation of choice for the majority of cases of major trigeminal neuralgia, particularly if the patient is old, or the neuralgia severe.

Section of the sensory root at the pons according to Dandy's method was performed in most of the early cases in this clinic, but later only in cases with more exact indications.

A total of 145 patients were operated upon up to Dec. 31, 1948 by this method (in this series cases of bilateral neuralgia are not included.) Keratitis, facial weakness, and paresis of the masticatory muscles seldom occurred, and the records show that only 8 patients complained of very slight paresthesias in the anesthetic area of the face, due to the fact that with Dandy's method there is very insignificant, if any, loss of tactile sensation in the face.
In spite of these advantages, the method is unsuitable for routine operations, because of the high mortality rate (3.4 per cent), and the greater frequency of recurrence (17.9 per cent) compared with that of Frazier (8.3 per cent). It is indicated rather in those cases in which clinical signs suggest the existence of an expansive process of the angle.  

Section of the descending fibers of the trigeminal tract in the medulla oblongata should be the ideal method because the sense of pain and temperature are abolished, without loss of the sense of touch; subjective numbness is practically absent; in all instances the motor root is preserved; facial weakness and keratitis do not occur.  

Although most of the disturbances, particularly those of gait and station, and paralysis of the vocal cords, which occurred in a considerable portion of the earlier cases in which the incision was made at a level corresponding to the border between the middle and the inferior third of the olivary eminence, could be avoided by sectioning the tract at the level of the obex, or caudal to it, this operative method still has undesirable effects that limit the field of application. These are principally: a higher operative mortality compared with the Frazier method; longer hospitalization; relative frequency of recurrence.  

Bearing in mind that trigeminal neuralgia usually affects older subjects, often those with arteriosclerosis and hypertension, it will be understood that this surgical measure cannot be used systematically for all patients. It should be reserved for those who are young or middle-aged, and in good general condition, for whom preservation of the tactile sensation in the face is desirable, and in whom, in case of recurrence, a secondary operation some years later could be performed without danger to life.  

For patients suffering from particularly severe neuralgia, in whom subsequent recurrences are most likely to occur, tractotomy is not recommended, nor in those cases in which the neuralgic pain is exclusively, or principally localized in the 3rd trigeminal division. This is not because it is difficult to obtain analgesia in this territory, but because it is potentially more dangerous.  

In conclusion, tractotomy is indicated in those patients who are young, and in good general condition, with moderately severe trigeminal neuralgia especially if localized in the ophthalmic and maxillary areas. (Indications for tractotomy in cases of bilateral trigeminal neuralgia will be discussed in a later paper.)  

SUMMARY  

A total of 124 patients with major trigeminal neuralgia have been subjected to section of the descending fibers of the trigeminal tract in the medulla oblongata. Because of a modification of the original operation, the patients fall into two groups: those (40) in whom the trigeminal tract was sectioned at a level corresponding to the border between the middle and the inferior third of the olivary eminence; and those (84) in whom it was per-
formed at a level corresponding to the lower end of the 4th ventricle. This modification has practically eliminated the danger of laryngeal palsy, and the disturbances of gait and station.

Considering that the trigeminal tractotomy is an intervention which is potentially more dangerous than section of the sensory fibers by the sub-temporal approach, and because it is followed by a relatively great number of recurrences, it cannot be used as a routine measure. It is indicated in a restricted number of subjects in whom preservation of the tactile sensation in the face is desirable, and in whom, in case of recurrence, a secondary operation can be performed without risk to life.

Tractotomy is thus indicated in young and middle-aged subjects, in good general condition, and with moderate neuralgia, especially if localized in the ophthalmic and maxillary divisions.

REFERENCES