Combined extra-intradural temporal rhizotomy for the treatment of trigeminal neuralgia

Results in 409 patients

GIULIO MORELLO, M.D., MARIO BIANCHI, M.D., AND FRANCO MIGLIAVACCA, M.D.
Neurosurgical Department, Milan Neurological Institute, Milan, Italy

The authors describe a modified temporal trigeminal rhizotomy whereby the fifth nerve root is approached extradurally and then reached intradurally. The results obtained in 409 cases of trigeminal neuralgia are summarized. The method has no greater risks than the extradural method and has the advantage of a lower incidence of postoperative facial paralysis and a greater chance of sparing the motor root.

Key Words: trigeminal neuralgia, facial paralysis, trigeminal nerve, rhizotomy

TRIGEMINAL rhizotomy for essential trigeminal neuralgia was first performed in 1891 by Horsley, et al., using the intradural temporal route. It was not a subtemporal rhizotomy as understood today, that is, section of the root in the middle cranial fossa, but rather a temporal craniectomy, opening of the dura, raising of the temporal lobe, exposure of the root proximally to the porus trigemini, and “avulsion of the nerve from its attachment to the pons.” A technique similar to juxtaponine rhizotomy but carried out transtentorially was later described by Dogliotti and by Jannetta and Rand. Horsley’s patient died, and rhizotomy was not attempted again until 1901 when, at Spiller’s suggestion, it was resumed by Frazier, who severed the nerve in the middle cranial fossa by extradural temporal route according to the method then in use for exposing the Gasserian ganglion. Trigeminal rhizotomy thus became established and was later improved with sparing of the motor root (Peet) and selective section of the fibers innervating the neuralgic area (Stookey). So far, all things considered, it has proved to be the best operation, because of its low incidence of complications, recurrence, and operative mortality.

The original extradural approach was used without exception for a long time, but over the past 30 years several accounts of the use of an intradural approach have appeared. The first passed almost unnoticed, that of Herrmann, who in 1940 reported his own and Wilkins’ experiences; Schörcher reported two cases in 1942. In 1945, Sachs wrote that, having tried Wilkins intradural method, he did not think he would ever go back to the extradural route. There followed the accounts of Portugal, Wilkins, Barcia Goyanes, Bertrand and Phéline (14 cases), Kurbangaleev (17 cases), Zoltán (64 cases), Davini (25 cases), Kunicki (143
Combined extra-intradural fifth nerve rhizotomy

cases), and again Wilkins (1966–1971) cases. The proponents of the intradural route say that its advantages are: 1) the venous sinuses of the dura of the base of the skull near the foramen ovale, which can give rise to troublesome bleeding, are avoided; 2) as the dura does not have to be stripped from the base of the skull in the immediate vicinity of the Gasserian ganglion, traction on the greater petrosal nerve, the commonest cause of facial paralysis, is avoided; 3) most important, complete exposure of Meckel’s cave from above ensures easy access to the sensory root, which can be severed selectively and the motor root spared.

Although all who have written from personal experience are satisfied with the intradural approach, it has not so far been extensively adopted. Having tested it thoroughly, we feel that preconceived mistrust rather than an objective appraisal underlies its lack of adoption. Temporal rhizotomy had always been performed extradurally at this hospital until 15 years ago, when a chance happening prompted us to change tactics. In 1955 the senior author, when operating on an elderly woman, was in difficulty because the dura, which was very thin and closely adherent to the floor of the middle fossa, kept tearing badly. To complete the operation he had no option but to continue inside the dura, and he found that in this way it was much easier to reach the root. What had started as a makeshift matter became deliberate policy. After some improvements in technical detail, the combined extra-intradural route came to be our standard, indeed only, method.

Operative Technique

The operation is done under general intratracheal anesthesia with the patient seated. The first steps are as in Frazier’s extradural approach. A straight temporal incision is made perpendicular to the midpoint of the zygomatic arch, followed by a small temporal craniectomy, after which we proceed extradurally as far as the foramen spinosum, plugging it with cotton to ensure hemostasis of the middle meningeal artery. A straight anteroposterior incision 5 to 6 cm long is then made in the dura flush with the floor of the middle fossa (Fig. 1). A spatula is inserted to raise the temporal lobe, largely covered and protected by the dura, and the
laterally, six patients had previously had neuralgia on the side opposite to that for which they were operated on here: in two (one with disseminated sclerosis) it cleared spontaneously; in one it was very slight and remained so; in three it ceased after operations at other hospitals (alcohol ganglion injected in one case, Frazier's operation in another, and alcohol ganglion injection and Dandy's operation in the third).

Further, after the operation at this hospital 20 patients had neuralgia on the other side: in seven it was mild, in 10 fairly severe but well controlled by carbamazepine, in two it disappeared after alcohol branch injection at this hospital, and in one it disappeared after Frazier's operation performed elsewhere. Altogether, there were 28 cases (6.8%) of bilateral neuralgia, in some cases severe and lasting.

Nearly all the patients had been given analgesics or sedatives and some had had specific treatment for trigeminal neuralgia; 64 had been treated with carbamazepine, which in 57 was ineffective from the start or became so in the course of treatment, while in seven it had to be discontinued because of unpleasant or dangerous side-effects (leukopenia in five, asthenia in one, dizziness in one). In 86 cases, alcohol branch injection had been done elsewhere and in 19 had produced some harmful effect. In 15 cases, alcohol ganglion injection had been performed (in one case at this hospital) with untoward results in five (facial paralysis in two, paralysis of the abducens nerve in one, immediate and violent worsening of the pain in one, and meningitis in one). Peripheral neurectomy had been performed in 23 cases, Frazier's operation in 13 (three here and 10 elsewhere), Dandy's operation in two (elsewhere), and Taarnhoj's operation in one (elsewhere).

**Mortality**

There were 445 operations performed with the combined technique described: 411 primary operations (407 unilateral and two bilateral cases), 32 reoperations because of immediate failure or late recurrence, and two operations for second recurrences. Three patients died as a result of the operation (case mortality = 0.73%; operative mortality = 0.67%). One died during operation while the foramen spinosum was being plugged, and not even complete necropsy disclosed the cause of death. Another did not regain consciousness after a technically uneventful operation and died on the second postoperative day; necropsy was not per-
Combined extra-intradural fifth nerve rhizotomy

formed. A third patient, whose preoperative electrocardiogram had been normal, died of myocardial infarction on the seventh postoperative day.

Complications

General complications occurred in four patients, all over 70 and one operated on for recurrent neuralgia; these patients developed bronchopneumonia but all recovered without sequela.

Hemorrhage. In five operations (four primary and one for recurrence), copious arterial bleeding from inside Meckel’s cave occurred during rhizotomy but was arrested with Gelfoam. In two of these cases, the postoperative course was quite uneventful; in the third, ipsilateral paralysis came on immediately after operation but cleared up almost completely later; in the fourth, contralateral crural paresis appeared on the third postoperative day and cleared up almost completely in 3 weeks; in the fifth a mild contralateral hemiparesis came on immediately after operation, receding to a large extent later, although not disappearing altogether.

Hemiparesis. Five other operations (three primary and two for recurrence) were followed by contralateral hemiparesis. The onset was immediate in four patients: in three (aged 44, 61, and 80, one of whom was operated on for recurrence) the hemiparesis cleared up completely in less than a month whereas in the fourth (aged 62 and operated on for recurrence), who also had aphasia, the damage was permanent. In the fifth case (a man of 83) the hemiparesis appeared on the 20th postoperative day and cleared up completely in under 2 months. Altogether, the incidence of contralateral hemiparesis or monoparesis was 1.57% (7 of 445 operations), but lasting motor impairment occurred only in 0.44% (2 of 445).

Aphasia. In addition to the cases mentioned earlier, six other patients who had operations on the dominant side had transient aphasia, appearing from the first to the sixth postoperative day and clearing up completely in all cases within 1 to 3 weeks.

Facial Paralysis. Ipsilateral peripheral facial paralysis occurred after 16 primary operations and never after secondary procedures (case incidence = 3.91%; operative incidence = 3.59%). Paralysis appeared 8 times within the first 3 days and 8 times between days 4 and 10. In 10 cases it cleared up completely and fairly quickly, in two it receded markedly but had not disappeared on discharge and the patients were not followed up; the four cases in which it was permanent came on within 3 days of operation. The incidence of lasting facial paralysis was thus 0.97% by cases and 0.89% by operations. Immediate ipsilateral oculomotor or abducent paralysis or paresis occurred after eight operations, four of which were for recurrence; in seven of these cases it cleared up completely within a month at most; in one, operated on for recurrence, the oculomotor paresis was permanent.

Corneal Anesthesia. Corneal complications occurred in eight cases (case incidence = 1.94%; operative incidence = 1.79%). Interstitial keratitis developed in five cases (one secondary procedure) immediately after operation and in three from a few months to a year later; in all cases it was cured without appreciable visual damage by permanent partial tarsorrhaphy. This operation was performed as a precaution in 47 other patients whose occupation (farming, carpentry, etc.) exposed them to the risk of corneal irritation; three of them managed to persuade undisclosed oculists to reopen their eyelids completely and shortly after developed keratitis; fortunately this was cured by another partial tarsorrhaphy without serious sequelae. Immediately after the operation one patient had hemotympanum, which passed off within a few days, leaving no sequelae.

Immediate Results

The neuralgia ceased in all but three cases, in which section of the root had been too niggardly, for it was at once evident that the painful area had virtually normal sensation and in fact the neuralgia returned within a few days. One patient refused reoperation and 7 years later was still suffering from neuralgia. The other two were reoperated on at once: one was free of pain over 2 years later, and in the other neuralgia returned after 18 months. Sensation was tested before discharge in 408 survivors of the primary operation and in the above two subjected to secondary procedures: in 182 the anesthetic area was larger than the painful area, in 138 equal, and in 90 the painful area was almost but not completely anesthetic. Motor root function was intact in 213 cases (on both sides in
the two patients operated on for bilateral neuralgia) and impaired in varying degree in 152; in 43 it was not examined.

**Follow-Up**

Some patients appeared of their own accord as outpatients, and many others were seen at two follow-ups (1956 and 1963); in 1968 we reviewed all patients who had been operated on more than 2 years before. During these follow-ups, it was found that recurrence had taken place in 44 cases, 31 of whom underwent a secondary operation. It was also found that five patients had painful anesthesia, which in three had come on immediately after the primary operation, in one 6 months later, and in the fifth 1 month after a secondary procedure. There were 19 patients (6.2% of the 305 cases followed for more than 2 years) who reported that they had troublesome, though not painful, paresthesia in the anesthetic area, in all cases after the primary operation. Mild paresthesia was present in another 79 cases, in eight of them after a secondary procedure. The extent of sensory denervation and motor root function were tested at follow-up after 201 primary operations; the findings are compared with those on discharge in Tables 1 and 2.

**Recurrences**

Neuralgia returned in 44 cases after a variable period: in seven after 6 months, in five after 7 to 12 months, in 10 after 1 to 2 years (one had undergone a secondary procedure for immediate failure), in eight after 2 to 3 years, in three after 3 to 4 years, in six after 4 to 5 years, and in five over 5 years after operation. In six cases the recurrence affected an area previously not painful and not denervated; in 38 the pain returned in the previously affected area, which immediately after the operation had been found to be incompletely denervated in 32 and completely anesthetic in six, though in these some sensitivity later returned.

There were 13 patients who underwent no secondary procedure: two refused it; eight had very mild or carbamazepine-controllable neuralgia; in two, one of advanced age and the other a poor surgical risk, recurrence was confined to the area of one branch and alcohol injection of this was sufficient to ensure lasting cure. One patient was successfully operated on by temporal extradural route at another hospital.

There were 31 patients who were operated on again by the intradural route at this hospital. One of them, as mentioned above, had already been subjected to a secondary procedure for immediate failure and had gained relief for only 18 months. Four patients were over 70 and two over 80 at the time of the secondary procedure. In six cases, during the new operation the root fibers were stuck together, thus rendering differential rhizotomy difficult. There was no operative mortality. The complications and sequelae have already been discussed. In all cases the neuralgia was relieved again. The painful area had become completely anesthetic in all but one, in whom denervation was incomplete; this man had a further recurrence 2 years later and although at the third operation the root could not be severed properly, the neuralgia ceased again and had not recurred when the patient was seen 2 years later.

**TABLE 2**

*Motor root function in 201 primary cases*

<table>
<thead>
<tr>
<th>Denervation on Discharge</th>
<th>Denervation at Follow-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intact</td>
</tr>
<tr>
<td>not tested</td>
<td>10</td>
</tr>
<tr>
<td>intact</td>
<td>115</td>
</tr>
<tr>
<td>impaired</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>166 (82.5%)</td>
</tr>
</tbody>
</table>

* Anesthetic area same as on discharge in one case, smaller in one, larger in one.
Combined extra-intradural fifth nerve rhizotomy

**TABLE 3**

*Comparison of extradural and intradural approaches to temporal trigeminal rhizotomy*

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>No. of Cases</th>
<th>Mortality (%)</th>
<th>Facial Palsy (%)</th>
<th>Relapse (%)</th>
<th>Corneal Complic. (%)</th>
<th>Painful Anesthesia (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extradural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peet and Schneider (1952)</td>
<td>544</td>
<td>1.6</td>
<td>6.5</td>
<td>14.1</td>
<td>15.1</td>
<td>30.4(?)</td>
</tr>
<tr>
<td>Ruge, <em>et al.</em> (1958)</td>
<td>627</td>
<td>0.63</td>
<td>6.5</td>
<td>1.1</td>
<td>3.7</td>
<td>4.8</td>
</tr>
<tr>
<td>Stookey and Ransohoff (1959)</td>
<td>656</td>
<td>0.82</td>
<td>7.8</td>
<td>13.0</td>
<td>0.98</td>
<td>10.0</td>
</tr>
<tr>
<td>Wertheimer (1960)</td>
<td>326</td>
<td>1.5</td>
<td>3.4</td>
<td>15.3</td>
<td>7.0</td>
<td>11.7</td>
</tr>
<tr>
<td>Olivecrona (1961)</td>
<td>445</td>
<td>0.4</td>
<td>10.8</td>
<td>8.5</td>
<td>1.3</td>
<td>3.1</td>
</tr>
<tr>
<td>Benedetti and Nori (1964)</td>
<td>254</td>
<td>0.78</td>
<td>7.3</td>
<td>13.0</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>Intradural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morello, <em>et al.</em> (1971)</td>
<td>409</td>
<td>0.67</td>
<td>3.6</td>
<td>14.4</td>
<td>1.79</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Motor root function, which immediately before reoperation had been intact in 23 patients and impaired in varying measure in eight, immediately afterward was intact in 13, impaired in 10, and absent in eight.

**General Results**

The 356 patients who had an operation, either primary or secondary, more than 2 years previously were asked in 1968 to attend our outpatient department or to answer a questionnaire. Of this total, 44 were lost to follow-up, and 26 were known to have died. Of the 26 patients who died, we heard nothing of the outcome of the operation in seven of them; 18 (including three who underwent secondary operations) had had no further pain up to their death (from 11 mos to 12 years for the primary operation cases and from 3 to 7 years for the second operation cases); one had had a relapse 2 years 4 mos after a primary operation and the neuralgia lasted right up to death from apoplexy 16 months later. There were 286 patients (including 20 reoperated) who attended the follow-up examination or supplied trustworthy written information: 12 still had or had had neuralgia; five had painful anesthesia; the other 269 had been free of pain since operation, primary or secondary, from 2 to 13 years.

In summary, 305 (85.6%) of the 356 patients operated on more than 2 years earlier were followed up satisfactorily and 287 of them (93.4%) had lasting benefit from a primary or secondary operation.

**Discussion**

We consider that, by and large, our results compare favorably with those of the larger extradural operation series reported in the past 30 years (Table 3).\(^{2,12,14,17,22-24}\) There are also some points worth emphasizing in greater detail.

The main reason that the intradural route is unpopular relates to the fear that the temporal lobe, being directly exposed, may be injured (Peet and Echols,\(^{23}\) White and Sweet\(^{23}\)). Still more pessimistic is the opinion of Umbach\(^{23}\) who, while admitting that he had had no personal experience with the intradural route, considered that its defects included greater risk of infection, risk of lesion to the vessels of the cerebral cortex, and risk of confusing the temporal lobe and brain stem or adjacent cranial nerves. Oddly enough, none of the proponents of the intradural approach named earlier has ever reported incidents of this kind. Only two have mentioned difficulties peculiar to the method: transient edema of the temporal lobe (Kurbangaleev\(^{10}\)) and loss of cerebrospinal fluid, which may cause headache and high fever (Barcia Goyanes\(^{1}\)). We have never had a case of the latter.

Granted that ample exposure of the temporal lobe may create a risk, this is obviated by our method, for the dura is not opened immediately after craniotomy as with other intradural methods; the roof of Meckel’s cave is reached by an incision made early in the procedure medial to the foramen spinosum. Hence, direct exposure of the brain is con-
fined to a small part of the basal aspect of the temporal lobe; the greater part of this aspect and the whole of the external aspect, covered by the dura, do not come into contact with the spatula that elevates the lobe. We personally have never seen temporal lobe contusion or laceration of cerebral vessels but, as stated above, seven of our patients had contralateral hemiparesis, which cleared up completely in five and was probably due to surgical injury of the brain. However, this complication is not peculiar to the intradural approach; cases similar to ours and even more serious have also been reported for extradural operations. Indeed, in the series of Stookey and Ransohoff there were nine cases of transient hemiparesis out of 656 operations (1.3%) and in the series of Peet and Schneider (553 cases) there were two deaths from ascertained operative injury to the temporal lobe. We therefore think that the extradural approach, especially our method, is not more hazardous than the intradural approach.

The copious arterial hemorrhage from inside Meckel's cave, which happened in five of our cases, is puzzling. It is unlikely to have come from the carotid artery because, if it had, it could not have been so easily arrested with gelatin foam. These five patients were operated on either when the new technique had just come into use or by a member of our team who had not yet had much experience, and so in all cases the surgeon was unable to identify the source of bleeding. Perplexing incidents of this kind have occurred during extradural operations too. Stookey and Ransohoff reported one fatal case, and the damaged vessel was not identified. Peet and Schneider mentioned four cases of heavy bleeding during the rhizotomy, all of which recovered; in all four the injured vessel was identified: in two it was the cavernous sinus, in one the internal carotid artery, and in one an abnormal vessel at the hiatus Falloppii. And so, not even from the viewpoint of avoiding these hemorrhages from Meckel's cave, is the extradural route superior to the intradural route.

We feel our method is clearly superior in preventing facial paralysis. In our series this complication occurred after 16 operations (3.6%), a decidedly lower rate than in any series of cases operated on extradurally excepting that of Wertheimer. Even better results were those of Wilkins, in whose series of 314 operations facial palsy occurred only twice (0.63%), and those of Portugal, who in a personal communication related that no facial palsy occurred in more than 1000 patients, most of whom were operated on intradurally.

As to the better chance of sparing the motor root by one or the other approach, there is detailed information on only two series. For the extradural operation there is the series of Ruge, et al., who reported preservation of the motor root in 206 out of 627 cases (32.8%); for the intradural operation there is our series, in which motor function was found to be intact in 213 out of 365 cases (58.3%) when it was tested immediately after operation and in 166 out of 201 (82.5%) at follow-up. Therefore, if one can make a decision on the basis of two case series only, it is decidedly in favor of the intradural approach.

The recurrence rate of our series (44 of the 305 primary operation cases followed for over 2 years, or 14.4%) is among the highest reported. In 38 cases denervation had been inadequate or the anesthetic area, large enough at the outset, had shrunk later on. Thus the high recurrence rate is due not to a defect in the method but to a shortcoming on the part of the surgeon, who spared too much of the root. This view would seem to be substantiated by the results of secondary procedures. Indeed, in 31 of these the neuralgia disappeared again and has not recurred in the 20 cases followed for more than 2 years from the second operation. This finding has convinced us that, to safeguard against recurrence, denervation in primary operations should go a good bit beyond the painful area. This precaution applies particularly to older patients and poor surgical risks.

We feel that the extra-intradural method practiced at this hospital appreciably reduces certain disadvantages and sequelae of Frazier's operation without aggravating the risks of this procedure; this is still the best way of treating essential neuralgia of the trigeminal nerve.

Addendum

In 1969, 37 more patients were operated on by this method without operative mortality, and there were no recurrences among the patients previously treated.

The first report on the results obtained with
Combined extra-intradural fifth nerve rhizotomy


When this paper was ready for publication a paper appeared on a very similar method tried on 10 patients (Rossi, G. F., and Viale, G. Combined extra- and intradural temporal approach for retrogasserian rhizotomy. Technical note. Neurochirurgia, 1970, 13:1–4).

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Address reprint requests to: Giulio Morello, M.D., Libero Docente, Viale Regina Giovanna, 11, Milano, Italy.