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RESEARCH

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Microvascular decompression for trigeminal neuralgia: an experience of 84 operated cases

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Abstract

Aim We retrospectively analyse and review the results of microvascular decompression performed for trigeminal neuralgia. We also discuss the surgical nuances, complication avoidance and compare our results with other reported studies.

Materials and methods This is a retrospective study in which the data of eighty-four patients who underwent microvascular decompression for trigeminal neuralgia in the last ten years from 2013 till May 2023 at our institute (Neuron hospital and SSG Hospital, Vadodara, India) was reviewed. The preoperative pain characteristics, radiology reports and the degree and duration of post-operative pain relief and neurologic outcome was assessed. MRI was done preoperatively in all the cases to rule out a secondary cause for trigeminal neuralgia. All the cases of secondary trigeminal neuralgia were excluded from the study. A favourable outcome was defined as a post-operative Barrow Neurological Institute pain intensity score of 1.

Results Eighty patients had excellent immediate postoperative pain relief without any need for medications. None of these patients have developed any recurrence of pain till date. Four operated patients did not experience any pain relief after surgery.

Conclusion Microvascular decompression for trigeminal neuralgia is a safe and effective procedure which treats the root cause of the disease and hence provides good long term pain relief.

Keywords Trigeminal neuralgia, Microvascular decompression, Trigeminal nerve, Neuralgic pain, Tic douloureux

Introduction

Trigeminal neuralgia or tic douloureux is defined by the International association for the study of pain (ISAP) as "a sudden and usually unilateral severe brief stabbing recurrent pain in the distribution of one or more branches of the fifth (trigeminal) cranial nerve" [1].

Trigeminal neuralgia is classified into two types:

1. Classic or primary "idiopathic": caused by a loop of blood vessel indenting the root entry zone of the trigeminal nerve.
2. Symptomatic or secondary:due to an intrinsic brainstem pathology like multiple sclerosis or lacunar infarction or due to extrinsic cerebellopontine angle pathology like neoplasms or vascular lesions.

Though initially responsive to medical management, some intervention is usually required after some years, when the medical management fails to provide adequate pain relief.

Currently, microvascular decompression, radio-frequency/glycerol gangliolysis, balloon compression of ganglion, stereotactic radiosurgery are some of the common modalities used to treat this condition.

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Table 1 Barrow Neurological Institute (BNI) grading for pain of trigeminal neuralgia

Grade	Pain severity
Grade I	No pain, no medication
Grade II	Occasional pain, not requiring medication
Grade IIIa	No pain but continued medication
Grade IIIb	Pain present but adequately controlled on medication
Grade IV	Pain present but not adequately controlled on medication
Grade V	Severe pain despite medication

In our institute, all the patients requiring intervention for trigeminal neuralgia are advised to undergo microvascular decompression (unless unfit for general anaesthesia), as it is the gold standard for the treatment of trigeminal neuralgia with a very low rate of recurrence in the long term.

We review our results of microvascular decompression for primary trigeminal neuralgia performed over the last 10 years.

Materials and method

The data of eighty-four patients with primary trigeminal neuralgia who underwent microvascular decompression was reviewed.

Cases of secondary trigeminal neuralgia were excluded from the study.

The diagnosis of trigeminal neuralgia is purely clinical, based on the characteristic distribution of pain, character of pain, the aggravating factors and initial response to carbamazepine.

The degree of preoperative pain was graded as per Barrow Neurological Institute (BNI) pain intensity score [2]. Only the patients with preoperative pain score of 4 or 5 were operated.

Patients with associated co-morbidities like smoking, hypertension, diabetes mellitus, ischemic heart disease etc. were not a contraindication to surgery. Such patients were thoroughly evaluated preoperatively and the associated co-morbidities were addressed pre-operatively. Presence of such co-morbidities did not impact the surgical procedure or the outcome (Table 1).

MRI of the brain is done preoperatively, to detect neurovascular conflict and to rule out secondary causes of trigeminal neuralgia.

Neurovascular conflict is best seen in balanced steady state free precision sequence (b-SSFP) (Figs. 1, 2, 3 and 4). However, absence of demonstrable neurovascular conflict on MRI is not a contraindication for surgery.

All the patients were operated by the first author. The degree and duration post-operative pain relief and

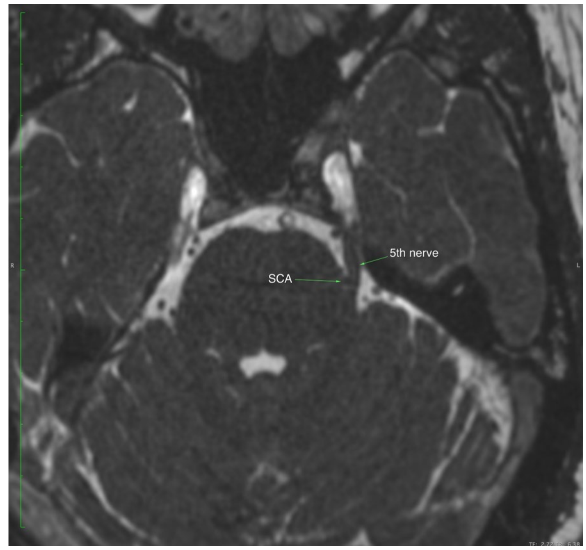

Fig. 1 Pre-operative MRI of brain Axial section B-SSFP sequence showing the SCA loop compressing the DREZ of trigeminal nerve

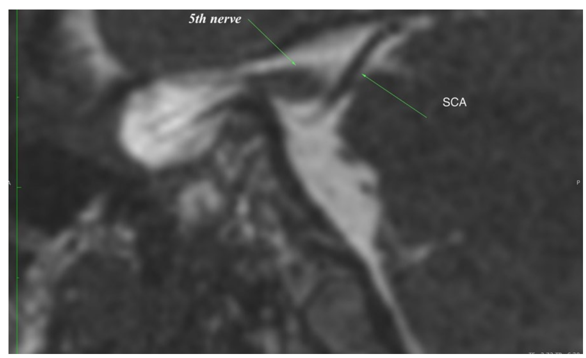

Fig. 2 Pre-operative MRI of brain sagittal section B-SSFP sequence showing the SCA loop compressing the DREZ of trigeminal nerve

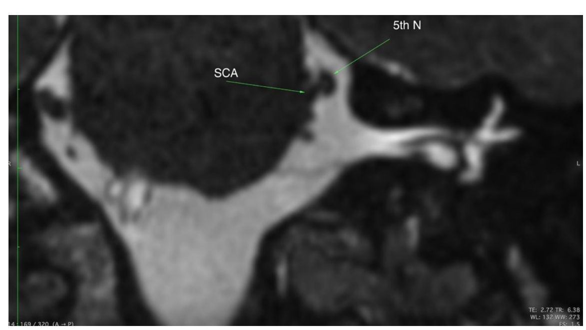

Fig. 3 Pre-operative MRI of brain coronal section B-SSFP sequence showing the SCA loop compressing the DREZ of trigeminal nerve

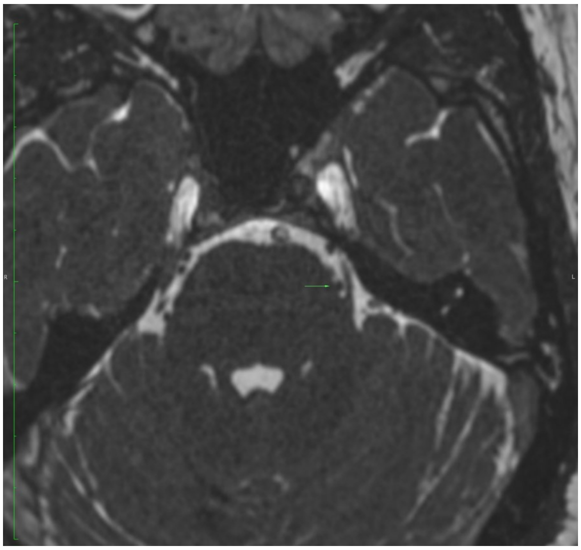

Fig. 4 Pre-operative MRI of brain axial section B-SSFP sequence showing the SCA loop compressing the DREZ of trigeminal nerve

neurologic outcome was assessed. A favourable outcome was defined as Barrow Neurological Institute (BNI) pain intensity score of 1.

Operative technique [3]: (Additional file 1: Video 1)

All the patients were operated under general anaesthesia using retromastoid approach. Majority of the parents were operated in supine position with the head turned towards the opposite side and the ipsilateral shoulder elevated to reduce venous congestion. The vertex is dropped slightly towards the floor. Initially, for obese patients and those with short stiff neck the surgery was carried out in the lateral position. As we gained experience, we do all the cases in supine position. The disadvantage of lateral position is that the shoulder may obstruct the view to the trigeminal nerve. The head is fixed in the Sugita head frame. A 5–6 cm linear incision is made 1–1.5 cm behind the tip of the mastoid.

The incision is widened by self retaining retractor. Pericranium and the neck muscles are stripped away from the underling bone by electrocautery. Pericranium can be harvested at this stage to be used later for duroplasty. A burr hole is made at the asterion at the approximate point of junction of the transverse and sigmoid sinus. If needed another burr-hole can be made medially and craniotomy is completed. Addition bone is drilled to expose the edge of the sigmoid sinus and the junction of the sigmoid and transverse sinus. Mastoid air-cells if opened are packed with fat or muscles. We do not prefer or advocate using bone wax as it is not an adequate sealant and can lead to infection. The size of the craniotomy is approximately 2–2.5 cm in diameter. As experience is gained, one can gradually decrease the size of the craniotomy.

Dura is then opened in a C-shaped fashion with the base towards the sigmoid sinus and hitched up by silk 4–0. Microscope and operating chair are now brought into use at this stage.

After covering the exposed cerebellum with cotton patties, the supero-lateral surface of the cerebellum is then gently retracted by the tip to the suction cannula to release CSF. Gradually as CSF is drained the cerebellum relaxes. It is important not to retract the cerebellum forcefully at the lateral surface as this will cause traction injury to the vestibulo-cochlear nerve, leading to hearing loss. During the initial cases we used Leyla retractor, but now we use dynamic retraction with no1 blunt tip suction cannula. As the cerebellum gradually relaxes, the Vein of Dandy comes into view. The arachnoid surround the vein is dissected and cut by sharp micro-scissors. The vein is then coagulated by bipolar forceps close to the cerebellar surface, to leave a small stump attached to the superior petrosal sinus. Avulsion of the vein from the sinus may lead to troublesome and difficult to control venous bleeding.

After the Vein of Dandy is cut, the trigeminal nerve covered by arachnoid comes into view. The arachnoid is dissected and cut sharply if necessary. It is important to go right to the origin of the trigeminal nerve at the brainstem, i.e. the dorsal root entry zone (DREZ).The culprit vessel is usually visible at this stage. The vessel is separated from the nerve by arachnoid dissection. It is important to cut the arachnoid binding the nerve and the vessel and if possible to change the course of the vessel away from the nerve.

After the vessel and the nerve are adequately separated, a Teflon patch is inserted between the nerve and the vessel.

After checking for hemostasis, the dura is closed with vicryl 4–0 and if needed pericranium or fascia lata is used. The bone flap and the bone dust collected during the burr-hole is replaced to prevent adhesions between the dura and muscles which can lead to headache.The muscles reapproximated and skin is sutured.

The patient is kept in the ICU for 3–4 h for observation.

Oral feeds are started after 3–5 h. Some patients may experience nausea, vertigo and one or two episodes of vomiting post-operatively, which usually settles down within 24 h.The patient is usually discharged on the 3rd or 4th post-operative day, and the stitches are removed on the 10th post-operative day.

Table 2 Sex distribution of patients

Sex	No of patients
Male	39
Female	45

Table 3 Age distribution of patients:

Age	No of patients
21–30	2
31–40	6
41–50	19
51–60	39
61–70	17
71–80	1

Table 4 Side of surgery

Side	No of patients
Right	36
Left	48

Table 5 Offending vessel

Offending vessel	No of patients
Superior cerebellar Artery (SCA)	79
Anterior inferior cerebellar artery (AICA)	3
Vertebral artery	1
Vein	1

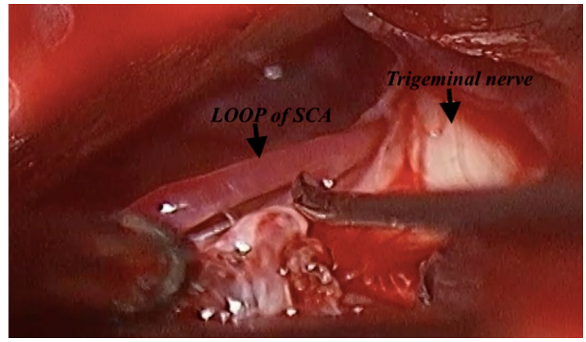

Fig. 5 Showing the loop of SCA compressing the trigeminal nerve

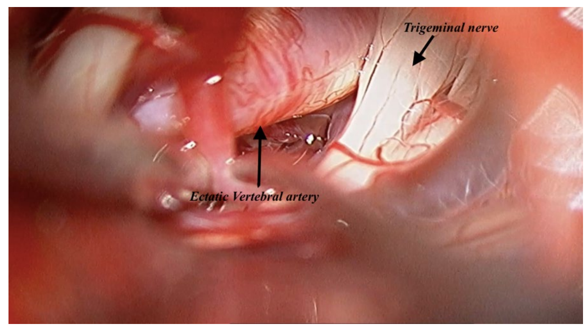

Fig. 6 Showing Ectatic vertebral artery compressing the trigeminal nerve

Results

The data is as follows (Tables 2, 3, 4 and 5):

Eighty patients had immediate and complete pain relief postoperatively and carbamazepine was stopped immediately after surgery. All these patients were followed up and remain pain free till date with BNI score of 1.The SCA was the most common offending vessel, seen in 79 cases (94%) (Fig. 5). Venous compression is extremely rare, seen in only one case. A dolicoectatic vertebral artery can cause trigeminal neuralgia, particularly in old age (Fig. 6). An abnormal course of AICA may also lead to this condition, as seen in three cases.

Four patients did not improve after surgery.The first patient developed herpes zoster over the eyelid on the fifth post-operative day, and its likely that the patient was erroneously diagnosed as trigeminal neuralgia.

The second patient initially improved but then developed pain over ear and throat and was diagnosed as having glossopharyngeal neuralgia. She was reoperated and microvascular decompression of the lower cranial nerves was done. She recovered completely after the second surgery.

The third patient which did not improve after surgery was advised re-operation but was lost to follow-up.

The fourth patient which did not improve had no significant neurovascular conflict. Carbamazepine was restarted but she failed to respond. She was re-operated after 8 months. During the second surgery, no significant pathology was detected. The patient had pain relief for two days, after which she developed recurrent pain. Psychiatric consultation was done and she responded to medications by psychiatrist (Table 6).

CSF fistula either through the wound or nose (paradoxical CSF rhinorrhea) was the most common complication, occurring in four patients. Two were treated by continuous lumbar drainage for five days and two were treated successfully by re-exploration and duroplasty by fascia lata graft. We now prefer re-exploration and duroplasty in all cases of CSF fistula when surgery has been performed in the infra-tentorial compartment as it has shorter hospital stay and is more definitively addresses

Table 6 Complications

Complications	No of patients	Treatment	Outcome
CSF fistula from wound	3	One treated by lumbar drainage of CSF. Two treated by re-exploration and duroplasty by fascia lata	Discharged without any sequlae
Paradoxical CSF rhinorrhea	1	Lumbar drainage for 5 days	Discharged without any sequlae
Opposite side 3rd nerve palsy	1	Conservatively by steroids	Recovered completely
Bilateral 7th, and 8th nerve palsy which developed progressively from the 4th postoperative day	1	Treated by steroids and azthioprine	Recovered completely
Delayed facial palsy and hearing loss15 days after surgery (unrelated)	1	Treated conservatively	Recovered completely

the leak.In addition, lumbar CSF drainage also carries a risk of meningitis.

One patient developed opposite side 3rd nerve palsy and other developed bilateral 7th and 8th nerve palsy. Both these conditions were most likely due to some autoimmune condition and responded to immunosuppressants.

There was no mortality in our series and none of the patients had any permanent neurological deficit or morbidity.

Discussion

The incidence of trigeminal neuralgia in the general population varies from 0.03% to 0.3% with a female to male ratio of 3:1 [4].In 90% of the cases, symptoms begin after age 40, and incidence progressively increases with age, with a peak between 50 and 60 years age group [5].

Initially, medical management by carbamazepine is nearly always effective for trigeminal neuralgia.Surgical intervention for trigeminal neuralgia is usually required after some years of medical treatment as the BNI score progressively worsens to 4 or 5 inspite of carbamazepine, or adverse effects of the drug like drowsiness, vertigo, ataxia begin to appear at higher doses.

The neurovascular conflict responsible for trigeminal neuralgia was first described by Walter Dandy in 1934, thought he did not attempt to decompress the nerve [6]. Microvascular decompression was first performed by Gardner in 1953 [7, 8]. The procedure was refined and popularised by Peter Janetta [9–11].

The surgical technique is of paramount importance in order to achieve a successful outcome. Great care should be taken during head positioning to avoid venous congestion and brain edema. The most important step is the drainage of CSF from the superior cerebellar cisterns and trigeminal cistern. This is done by gently depressing the supero-lateral cerebellar surface to release CSF and relax the cerebellum gradually. No attempt should be made to forcefully retract the cerebellum, as it will lead to injury to the Vein of Dandy or 7/8th nerve. It is also important to dissect the offending vessel of the trigeminal nerve root by sharp arachnoid dissection. Difficulty may arise when the loop is situated anterior to the nerve. In such cases gradual arachnoid dissection superior and inferior to the nerve can achieve the decompression. The Teflon patch should be of adequate size to prevent recurrence. As in any other surgery of the posterior fossa, watertight dural closure is of paramount importance. Pericranium from the upper part of the incision can be harvested for dural closure. If mastoid air cells are opened, the they should be sealed by fat and muscle. In some cases fascia lata from the thigh can be used for dural closure.

In our study, the success rate of the procedure was 95.23% which compares favourably with other case series [12–14]. Also, we if consider that the failure in three cases were due to an erroneous diagnosis, the success rate comes to 98.76% The failure of the procedure can be ascribed to only one case. None of the eighty patient has had recurrence till date.

Age of the patient and presence of other co-morbidities like diabetes mellitus, smoking etc. did not affect the outcome. Even older patients more than 60 years of age (total 18) had a good pain relief and had an uneventful postoperative course.

Stereotactic radiosurgery for trigeminal neuralgia has a mean success rate of about 50–60% and a recurrence rate of 40–50% [15]. Also, unfavourable BNI score of 4 or 5 is more likely with SRS [16] than MVD.

Stereotactic radiosurgery is very much expensive in terms of the equipment and treatment cost and very few centres in our country have the equipment. Our institute does not have the facilities for stereotactic radiosurgery.

Percutaneous radio-frequency ablation (RFA) has a success rate of 70 -100% with recurrence observed at after 8–40 months [17].

Also, they have more side effects like facial dysesthesia, keratitis, dry eye, deafferentation pain, mastication muscle weakness etc. [15, 17].

Alternative treatment modalities are offered to those who are not fit for general anaesthesia. With modern anaesthesia techniques, only a tiny subset of patients fall into this category. Also, because of the higher rate of recurrence, these alternative treatment modalities have to be repeated every few years, which puts a significant financial burden on the patients. This is particularly important in a developing country like ours where the patients may continue to tolerate pain in order to avoid the burden of expenses of a repeat procedure. In this context, MVD which provides long lasting and almost permanent pain relief is best suited for the developing countries. In this era of modern anaesthesia and microneurosurgery, there is hardly a patient who can't be offered permanent and definitive cure for trigeminal neuralgia by microvascular decompression.

Ours and other studies make a strong case to offer MVD only to all patients of trigeminal neuralgia, and use other treatment modalities in the rarest of rare circumstances.

Limitation of the study

Our study includes patients operated in the last ten years. Hence long term followup is not available for recently operated patients.

The duration of follow-up is 8–10 years for those operated in 2013 -2015 while its is 5–6 years for those operated at a later date.

Also, this is a retrospective study and no comparison is made between MVD and other treatment modalities.

Conclusions

Microvascular decompression for trigeminal neuralgia is a safe and effective procedure and our results compare favourably with other reported studies.

Abbreviations

MVD	Microvascular decompression
TGN	Trigeminal neuralgia
BNI	Barrow Neurological Institute
CSF	Cerebro-spinal fluid
MRI	Magnetic resonance imaging
ISAP	International association for the study of pain
RFA	Radio-frequency ablation
B-SSFP	Balanced steady state free precision
SCA	Superior cerebellar artery
AICA	Anterior inferior cerebellar artery
DREZ	Dorsal root entry zone

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41984-023-00248-3.

Additional file 1: Video 1. Operative video of MVD for trigeminal neuralgia.

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Not applicable.

Author contributions

The first author has operated all the patients and was involved in preparing the manuscript and the video. The second author was the assistant surgeon in few cases. Also she was involved in preparation of the manuscript and data collection and analyses. The third author was involved in data collection and analyses of data and preparation of tables.

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Availability of data and materials

All the data is available for scrutiny in the hospital records of SSG Hospital, Vadodara, Gujarat and Neuron hospital. The records contain all the case papers of the operated patients. We also declare that we have not used any other data set from any other source. We are ready to share the data as and when required with the journal.

Declarations

Ethics approval and consent to participate

The study was put up before the Neuron Hospital Ethics committee for cornet to publish the study in the journal. The Neuron Hospital Ethics committee has given the consent and clearance to allow the study to be published. All the patients, at the time of undergoing surgery, were in formed that the data may be used in future for publication in journals or academic meet and their consent to use the data without revealing their identity was obtained. The identity of any patient has not been revealed in the study.

Consent for publication

The patients had given written consent that the data may be used in future for publication in journals. We the authors also give our consent to publish the article if accepted.

Competing interests

We all the authors declare that we have no competing/conflict of interest of any financial gains for this study.

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