Abougamil *et al.*
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RESEARCH

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Sling technique in microvascular decompression surgery for trigeminal neuralgia: early experience and functional outcomes

Ahmed B. Abougamil[1*], Tamer Ibrahim Metwaly[2], Osama Ahmed Deif[2] and Wael Khedr[2]

Abstract

Background: Trigeminal neuralgia (TGN) is a facial pain disorder often caused by arterial compression of the trigeminal nerve. Microvascular decompression (MVD) remains the most definitive treatment for this disorder, with a reported cure rate between 60 and 80%. MVD techniques often involve a retrosigmoid craniotomy with placement of an inert foreign material, such as Gore-Tex or Teflon, between the nerve and the compressing vessel.

Recurrence of TGN after MVD has been associated with vessel migration and adhesion formation. In this study, we tested the use of Gore-Tex sling, fixed in place with fibrin glue to displace the compressing vessel away from the nerve.

Results: This is a retrospective study including 20 patients who had an MVD for treatment of idiopathic TGN where a sling of Gore-Tex was used with the application of fibrin glue to prevent dislocation of the vessel. It showed that sling MVD technique is an effective method for treatment of classic trigeminal neuralgia. Eighteen patients improved within 2 weeks postoperatively. One patient had recurrence of symptoms and was reoperated 1 year later.

Conclusion: Gore-Tex slinging technique is a safe simple technique for preventing re-dislocation of the offending vessel and thus recurrence of symptoms. However, larger series is needed to judge on the long-term efficacy and safety of this technique.

Keywords: Microvascular decompression (MVD), Trigeminal neuralgia (TGN), Gore-Tex, Sling

Introduction

Trigeminal neuralgia (TGN) is a facial pain disorder with a female preponderance. Vascular compression of the nerve at or near the root entry zone is the proposed pathology for the idiopathic form of TGN. Microvascular decompression (MVD), the gold standard treatment for TGN, often implicates separating the trigeminal nerve from the offending vessel by placing a foreign material, most commonly Gore-Tex, Teflon, or less commonly used materials, such as small pieces of muscle or gelfoam [1–5].

Cure rate following MVD ranges from 60 to 80%. Recurrence of symptoms is attributed to displacement of the vessel toward the nerve, development of adhesions, impingement of the foreign material against the nerve, and general failure of the operative technique. [6–8].

In order to address the deficiencies inherent in the current technique for trigeminal nerve decompression, other decompressive methods were proposed, basically slinging the offending vessel to the dura away from the trigeminal nerve. Dacron suture, Gore-Tex tape, aneurysm clips, surgical cellulose, gelatin sponge, as well as autologous graft, were used for this purpose [9–13].

*Correspondence: dr.ahmadbahy@gmail.com

[1] Department of Neurosurgery, King's College Hospital NHS Foundation Trust, Denmark Hill, London SE5 9RS, UK

Full list of author information is available at the end of the article

The aim of this study was to assess the clinical outcome of the slinging maneuver for the offending vessel in the context of MVD for TGN compared to the more commonly employed technique of separating the trigeminal nerve from the offending vessel using teflon.

Methods

A retrospective study was conducted revising the records of non-diabetic patients complaining of idiopathic TGN who underwent MVD using slinging maneuver for separating the compressing vessel from the trigeminal nerve. The study was performed in the main University Hospital, Department of Neurosurgery, Alexandria University, Egypt in the period from 2018 to 2020.

The following data were collected from each patient's filling records: (age, sex, residency, medical and family history).

All the patients had been treated with anticonvulsants, i.e., carbamazepine (up to 1200 mg per day) and/or colanzepam (up to 6 mg per day) for a period of at least 6 months, and most patients had never had complete pain relief with drugs (85%), the others (15%) could not tolerate the drugs.

All the patients were clinically examined before an MRI Brain with T2 constructive interference in steady state (CISS)/Fast Imaging Employing Steady-state Acquisition (FIESTA) sequence was done to identify the compressing vascular loop and to exclude brain tumors, vascular malformations and multiple sclerosis (Fig. 1).

Operative procedure

Preoperative single dose of intravenous third generation cephalosporine was given. Under general anesthesia, patients underwent a standard retrosigmoid craniectomy. Patients were positioned in the lateral decubitus park bench position, and the head was fixed to the operating table with Mayfield clamp and turned 30° to the contralateral side, allowing a space of one finger breadth between the chin and neck. A retromastoid curvilinear skin incision was made. The mastoid eminence, digastric groove, and inion were identified to define the transverse sigmoid junction.

A craniectomy was performed to expose the border of the transverse and sigmoid sinuses using the asterion as a landmark. The dura was opened parallel to both sinuses. Cerebrospinal fluid (CSF) was allowed to drain to relax the cerebellum and facilitate retraction. Gentle downward retraction was placed over the marginal aspect of the cerebellar surface. With slight elevation of the cerebellum identifying the petrosal vein, the trigeminal nerve could be seen. If a contact between the trigeminal nerve and a blood vessel is found at the site where the

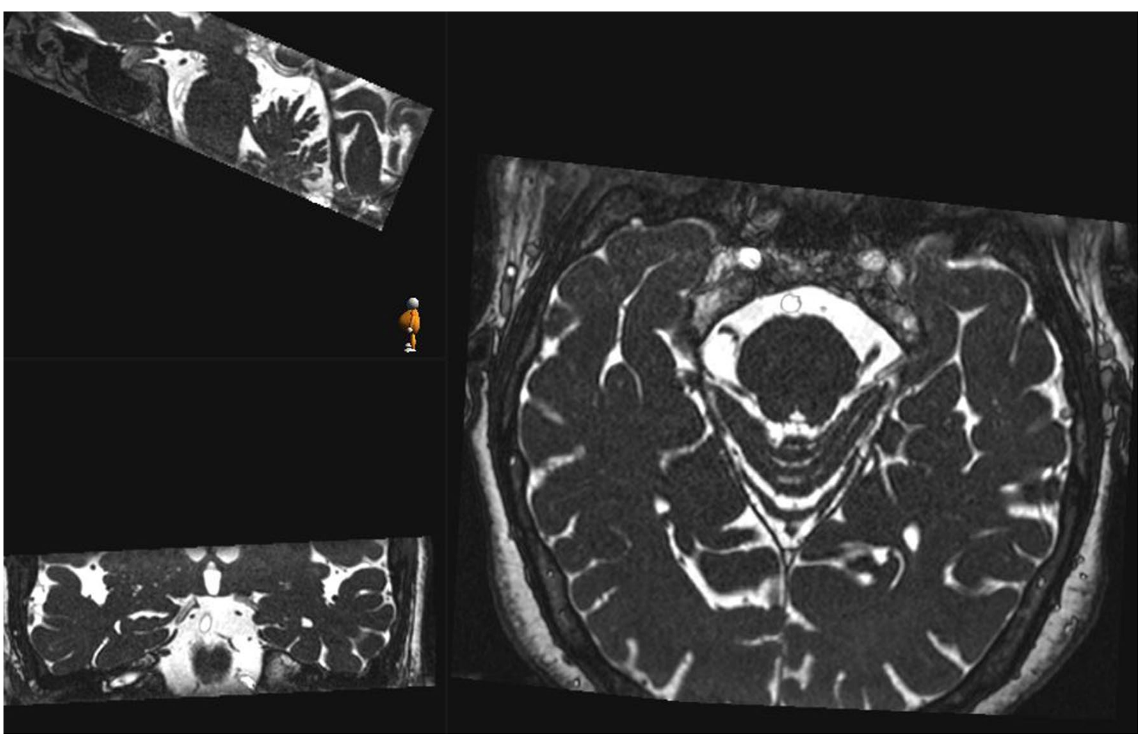

Fig. 1 Preoperative axial MRI with constructive interference in steady state showing an offending vascular loop near the right trigeminal nerve complex with reconstruction in the sagittal/coronal plane

nerve enters the brainstem, this neuro-vascular conflict is then dissected and mobilized away from the trigeminal nerve. We slung the offending vessel using Gore-Tex and attached it to the dura overlying the petrous bone using fibrin glue to prevent recompression (Fig. 2). The dura mater was closed in a watertight fashion. The wound was closed in layers. Postoperative intravenous cephalosporines were given for at least three doses (depending on the surgeon's preference).

Postoperative all patients were assessed for pain relief using the Barrow Neurological Institute (BNI) pain score.

Results

The records revealed 20 patients who fulfilled the inclusion criteria as shown in (Table 1); 12 males and 8 females with an age range from 35 to 70 years (mean 51.1 years). Twelve patients had right-sided neuralgia and eight had left-sided neuralgia. The pattern of trigeminal neuralgia according to V1–V2–V3 distribution is summarized in (Fig. 3).

Duration of symptoms before surgery ranged between 2 and 6 years. Two patients had a high blood pressure that was controlled medically preoperatively. The intraoperative findings of the different neuro-vascular conflict types are summarized in Figs. 4, 5.

All patients were assessed using Barrow Neurological Institute (BNI) pain score which stratifies pain into five grades:

(1) Pain free, no medication.
(2) Occasional pain, no medication required.
(3) Some pain, adequately controlled by medication.
(4) Some pain, not adequately controlled by medication.
(5) Severe pain or no pain relief.

Postoperatively, five patients had complete relief of pain on the second postoperative day. Thirteen patients had resolution of pain within 2 weeks postoperatively with satisfactory outcome in 85% of cases. Pre- and postoperative outcomes are illustrated in Fig. 6.

One patient had residual neuralgia and further developed recurrence of symptoms on the same side which were unresponsive to medical treatment and eventually needed reoperation one year later.

Postoperative complications were minimal, one patient had CSF leakage which was conservatively managed with repeated lumbar punctures, another case had superficial wound infection treated by intravenous antibiotic.

One patient had facial numbness mostly caused by excessive manipulation due to complex venous anatomy

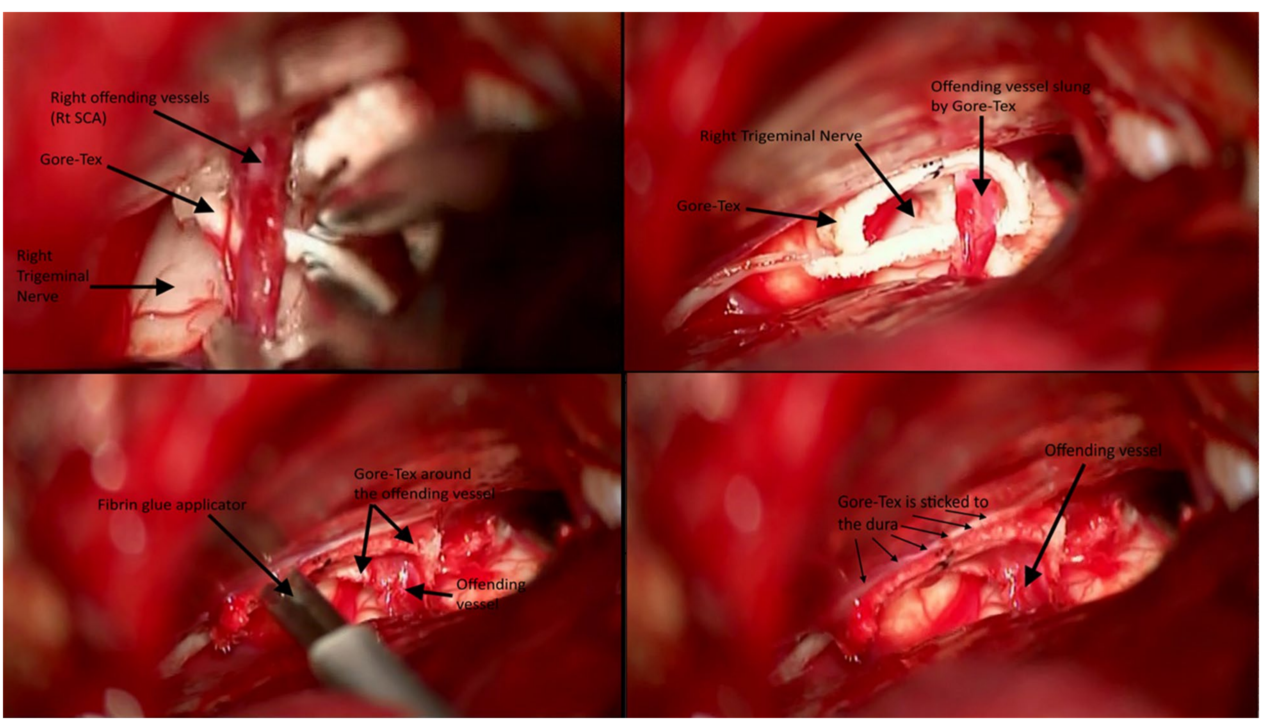

Fig. 2 Intraoperative pictures showing stages of MVD for treatment of right TN using the sling technique. The SCA is being slung with Gore-Tex away from the trigeminal nerve, fixed in situ using Fibrin Glue thus relieving the nerve compression

Table 1 Main information regarding preoperative, intraoperative, and postoperative course of the patients

Patient	Age/sex	Side	Distribution	Duration Symptoms to surgery	BNI Pain score	Offending vessel	Postop BNI pain score	Follow-up period (months)
1	45/M	Rt	V2–V3	3 years	IV	SCA	I	36
2	35/M	Rt	V3	2 years	IV	SCA	I	18
3	70/F	Rt	V2–V3	2 years	IV	SCA	I	26
4	48/M	Lt	V2–V3	4 years	V	AICA	I	36
5	38/F	Rt	V3	5 years	IV	SCA	I	40
6	42/M	Lt	V2	6 years	V	SCA	I	24
7	65/F	Rt	V2–V3	3 years	IV	SCA	I	36
8	55/M	Lt	V1–V2–V3	2 years	V	SCA	IV	Reoperated after 1 year, follow-up was 48 months from the 1st operation
9	47/M	Lt	V3	5 years	IV	AICA + veins	II	36
10	49/F	Rt	V3	4 years	IV	SCA	I	42
11	45/M	Rt	V2	6 years	V	SCA	I	36
12	55/M	Lt	V2–V3	3 years	IV	SCA	I	18
13	39/M	Lt	V2–V3	2 years	V	AICA	II	26
14	45/F	Rt	V3	5 years	IV	SCA	I	40
15	62/F	Lt	V3	4 years	IV	SCA	I	24
16	59/M	Rt	V2–V3	3 years	IV	AICA	I	38
17	55/M	Lt	V3	2 years	IV	SCA	I	42
18	60/F	Rt	V2–V3	2 years	V	SCA	II	36
19	68/M	Rt	V2–V3	4 years	IV	SCA	I	18
20	40/F	Rt	V3	5 years	IV	AICA	I	40

SCA Superior cerebellar artery, *AICA* Anterior–inferior cerebellar artery, *BNI* Barrow Neurological Institute

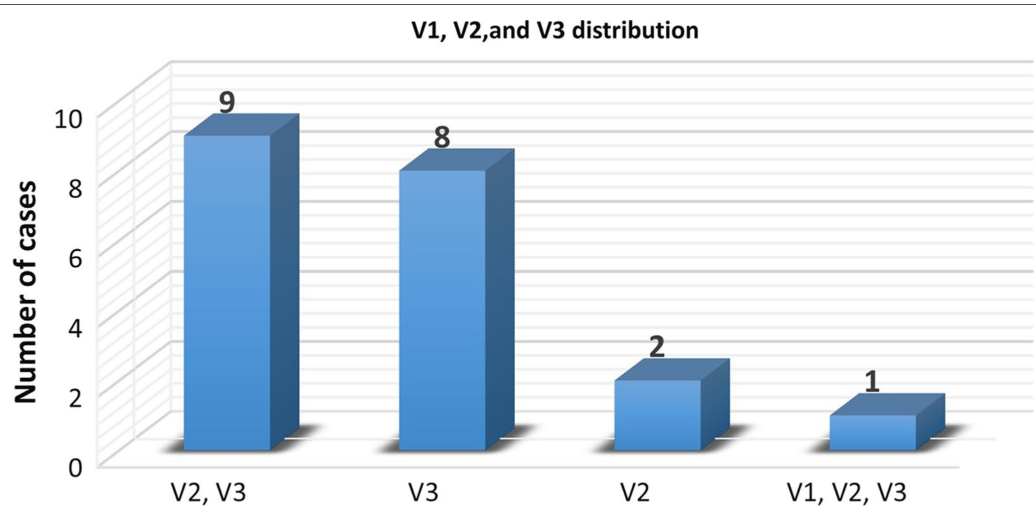

Fig. 3 Pattern of trigeminal neuralgia according to V1–V2–V3 distribution

of the petrosal vein and its tributaries that settled later on. Summary of postoperative complications is shown in Table 2.

Follow-up period ranged from 18 to 48 months with a mean of 33 months. Neither mortality nor severe surgery-related morbidity was reported in our study.

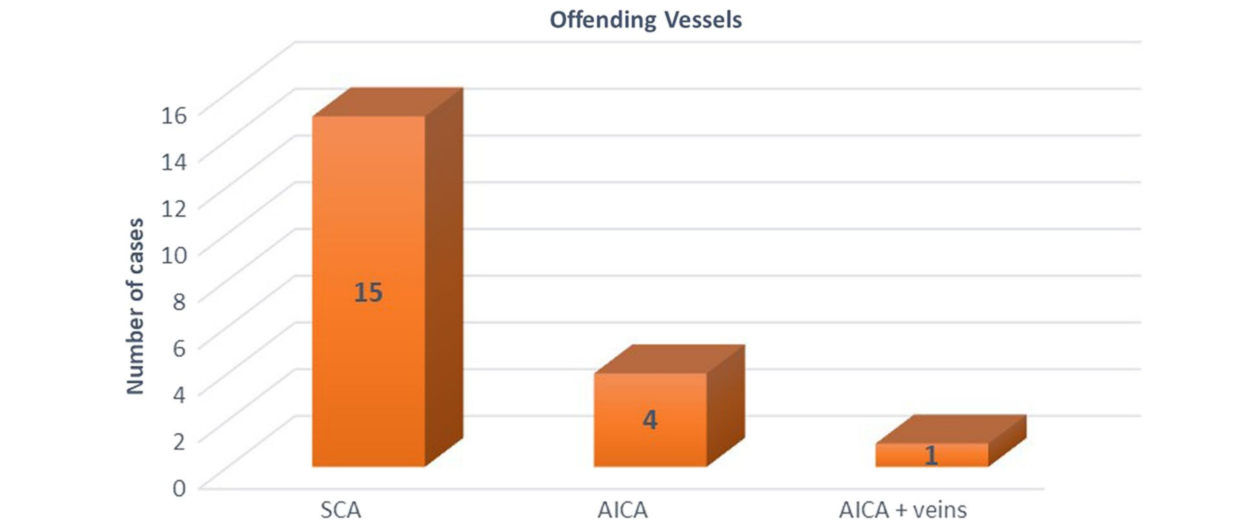

Fig. 4 The intraoperative findings of the different neuro-vascular conflict types

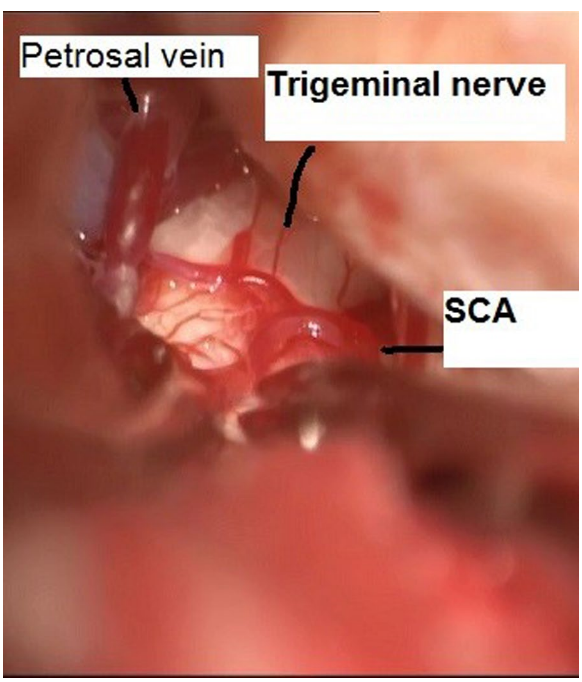

Fig. 5 An intraoperative picture during MVD showing the SCA exerting compression on the right trigeminal nerve

Discussion

This study confirms the validity of slinging the compressing vessel away from the trigeminal nerve as a viable alternative to the commonly employed technique of separating the compressing vessel from the trigeminal nerve using shreds of Teflon.

TN is typically a relapsing condition with pain-free intervals that might last months or years. The current standard of care begins with carbamazepine, which frequently relieves symptoms. Unfortunately, the comfort afforded by carbamazepine or other medicines may diminish over time, and adverse effects such as hyponatremia or trouble balancing may prompt discontinuation of the treatment. Approximately half of all patients will eventually require an operation to relieve their discomfort [14].

The patient characteristics in this series, such as gender, affected side, and affected division, were consistent with prior local and global reports [15, 16]. The pain was mostly right-sided (right to left ratio was 1.5:1), and the mandibular branch was the most affected.

MVD was standardized by Janetta where Teflon was inserted between the trigeminal nerve and the offending vessel. However, long-term follow-up studies revealed a gradual decline of the efficacy of MVD for treatment of TGN which occurred in 1–7% of cases where development of Teflon-induced granuloma and adhesions around the nerve caused by inflammatory response induced by Teflon was the suggested etiology [17–21]. Rzaev et al. [7] found that though Teflon granuloma is rare following MVD, it could lead to recurrence of symptoms mitigating initial improvement. Chronic inflammation without signs of bacterial infection can be induced by small amount of intraoperative bleeding which may lead to granuloma formation. Matsushima et al. [22] suggested the use of sling retraction instead of the interposing technique in fear of adhesion of the prosthesis to the nerve thus leading to recurrence. It is worth noting that Sindou et al. [23] compared the outcomes of patients with TN using

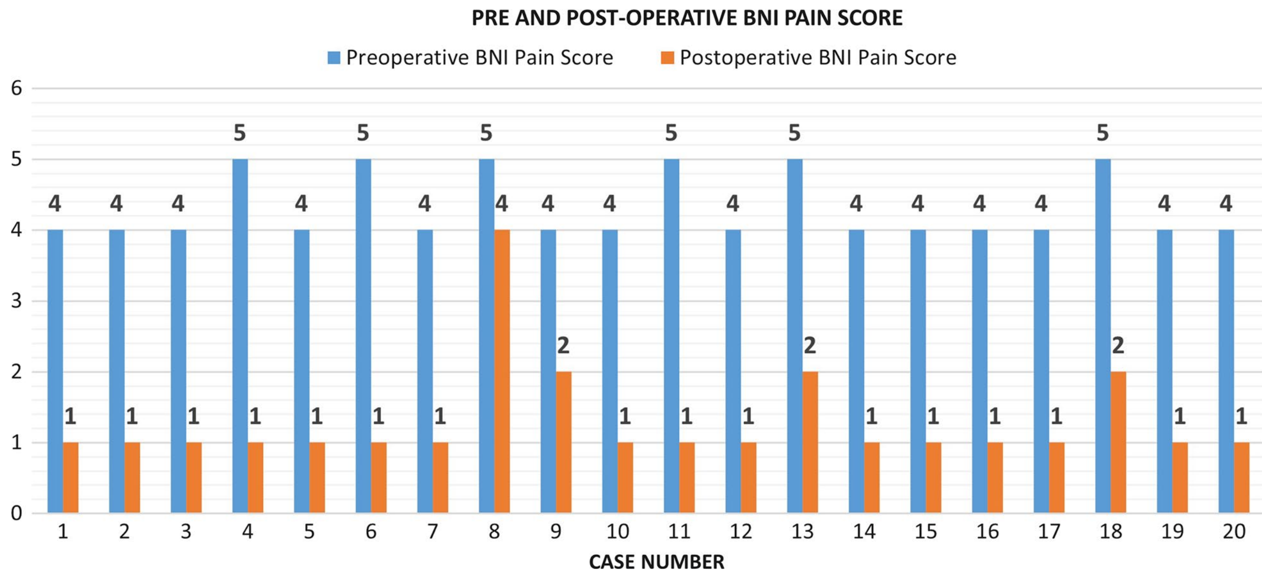

Fig. 6 Pre- and postoperative outcome using the Barrow Neurological Institute (BNI) pain score

Table 2 Summary of postoperative complications

Complication	Number (%)
Death	0
Facial palsy	0
Hearing loss	0
CSF leak	1 (5%)
Minor superficial wound infection	1 (5%)
Hematoma	0
Postoperative numbness	2 (10%)

two technical modalities in 330 patients and concluded that the 'no touching' procedure had a better long-term outcome than the 'touching' procedure.

In our study, we had 90% success rate and one case had recurrence of symptoms requiring reoperation, whereas Masuoka et al. found recurrence in 4% of patients undergoing the sling retraction technique [9, 24, 25]. The higher incidence of recurrence in our study is obviously due to the smaller pool of cases.

We encountered early improvement of symptoms in 90% of the cases nearly matching the results of Cheng J et al. who had immediate pain relief in 83% of cases, partial pain relief in 11% and failure in 5% [26].

Poshataev et al. stated that most cases of TGN are caused by arterial compression (90%) namely the SCA and AICA and rarely caused by venous compression by branches of superior petrosal vein [11, 27, 28]. Barker et al. found the SCA to be the main vessel in contact with the nerve (75.5%), the AICA was involved in 9.6%, the vertebral artery in 1.6%, the basilar and the posterior-inferior cerebellar artery (PICA) in 0.7% and the labyrinthine artery in 0.2%. A vein attributed to the compression in 68% of patients and was the only compressing vessel in 12% [12]. These results coincide with the results in our study where the SCA was the offending vessel in 75% of patients, AICA in 20% of patients, and in 5% of patients, the nerve compression was caused by the complex venous anatomy together with AICA, in which case the patient had facial numbness postoperatively notably caused by excessive manipulation needed for successful slinging and avoiding injury to the petrosal vein.

The technique of vascular transposition using sling retraction was originally developed by Fukushima [29], and a variety of sling retraction techniques have subsequently been reported using aneurysm clips [13], Gore-Tex tape [30] and fascia strips [31].

Steinberg et al. [1] published their large series of 45 patients who had MVD for trigeminal neuralgia using a tentorial sling technique where a 3- to 4-mm split-thickness strip of dura with a pedicle at the medial and deep aspect of the inferior tentorium was created. The dural sling is then wrapped around the compressive vessel and secured using a Weck® clip or a suture.

Although their results, similar to our cohort, are comparable to those of the traditional MVD technique, the unique tentorial sling method offers neurosurgeons an alternative surgical technique that can be used when reinforcing with foreign material alone does not provide adequate decompression.

On another hand Attabib et al. conducted a retrospective review of MVD operations in which the culprit vessel was transposed and then maintained in position with a fenestrated aneurysm clip secured in position by suturing it to the dura mater. Among a consecutive series of more than 450 MVD surgeries, the fenestrated aneurysm clip sling was used in eight cases: six for HFS and two for TN. Four of these six patients were undergoing reoperations [32]. Similarly, Shigeno [31] described his technique where Gore-Tex tape was directly snared around the artery and sutured over the petrous dura. However, both are technically demanding especially with availability of other options.

Limitations of the study

The retrospective design of the study is an obvious shortcoming. Ideally, a prospective double blinded study is the most informative, however, in the surgical context; it is difficult and may be unethical to conduct such a study. A small number of cases is another limitation due to low statistical power. However, significant advantages could still be reported from this small study group.

Conclusions

Slinging the compressing vessel away from the trigeminal nerve is a viable technique for maintaining the separation of the nerve from the offending vessel in the context of MVD. Moreover, slinging minimizes the recurrence of TGN as well as avoids granuloma formation that may evolve if Teflon is used to intervene between the trigeminal nerve and the compressing vessel.

Abbreviations

TN: Trigeminal neuralgia; MVD: Microvascular decompression; MRI: Magnetic resonance imaging; CISS: Constructive interference in steady state; FIESTA: Fast imaging employing steady-state acquisition; BNI: Barrow Neurological Institute; CSF: Cerebrospinal fluid; SCA: Superior cerebellar artery; AICA: Anterior–inferior cerebellar artery; PICA: Posterior–inferior cerebellar artery.

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Author contributions

AA has participated in performing surgical procedures, helped in writing and reviewing manuscript and data collection. TM has participated in performing surgical procedures; OD helped in writing and reviewing manuscript. WK participated in performing surgical procedure and helped in writing and reviewing manuscript and data collection. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study protocol was formally reviewed and approved by the ethics committee for human research at Faculty of Medicine, Alexanria University.

Consent for publication

In behalf of my co-authors, I hereby confirm that all the patients had capacity and consented to the operation of retrosegmid craniotomy for trigeminal nerve microvascular decompression in reference to the manuscript submitted.

Competing interests

The authors declare there are no competing interests.

Author details

[1]Department of Neurosurgery, King's College Hospital NHS Foundation Trust, Denmark Hill, London SE5 9RS, UK. [2]Departments of Neurosurgery, Alexandria Faculty of Medicine, Alexandria, Egypt.

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