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Microvascular decompression using muscle graft for interposition: A retrospective study

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Abstract

Introduction: This study aims to evaluate the outcome of Microvascular Decompression (MVD) using a muscle graft for interposition in Trigeminal Neuralgia (TN), Hemifacial Spasm (HFS) and Glossopharyngeal Neuralgia (GPN). All surgeries were performed by a single surgeon (G.R.S).

Methods and Materials: In total, 26 patients with trigeminal neuralgia, hemifacial spasm and glossopharyngeal neuralgia underwent microvascular decompression between September 2007 to April 2019. All the patients were either medically refractory or poor symptom tolerance. The mean follow-up period was 72 months.

Results: Each microvascular decompression was performed using an autologous muscle graft placed between the offending vascular loop and cranial nerve root entry zone. One patient (3.84%) had recurrence after microvascular decompression with muscle graft and two patients (7.69%) had partial relief.

Conclusion: Various types of prosthesis are used for transposition and interposition of vessels in microvascular decompression surgeries. Although in our case series we did not use any other kind of prosthesis other than autologous muscle graft for the comparative outcome, the use of muscle graft showed minimal recurrence rate with benefit of being cost effective. Therefore, we need randomized controlled trials to prove the superiority of muscle graft from other prosthesis material.

Key words: Interposing material, Microvascular decompression, Muscle graft, Surgical outcome.

Introduction

Microvascular decompression is the main procedure with the highest possibilities of providing a permanent cure for TN, HFS and GPN without risk of injury to the nerve; the main aim of MVD is to separate an irritating vessel from the nerve by interposing an isolating material between them. This method was developed by Gardner and Miklos [1] and discussed by Jannetta [2] after the introduction of microsurgery under an operative microscope. Several kinds of vessels of the posterior circulation are responsible for these diseases. These techniques are basically divided into two types: interposition technique and transposition technique. The interposition procedure involves insertion of a prosthesis between the vessel and nerve or brainstem. The transposition technique was developed primarily for transposing a torturous offending artery.[3] Various materials that are used to interpose or transpose the offending vessels including muscle pieces, dura mater, Teflon®, Ivalon® sponges, Gore- Tex®, polytetrafluoroethylene (PTFE), Prolene® sutures, silicon tubes, and aneurysm clip have been used in MVD. Amongst these, muscle graft is still in use due to its efficacy, cost effectiveness and less incidence of foreign body reactions which is discussed in this article. We have used only autologous muscle graft for microvascular decompression in our series and analyzed the retrospective outcomes.

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Methods and Materials

Patient selection

Among 26 patients who underwent MVD between September 2007 and April 2019, 22 (84.62%) presented with TN, 3 (11.54%) presented with HFS and 1 (3.85%) presented with GPN.

All patients underwent preoperative pure tone audiometry to identify any pre-existing hearing impairments. 3 Tesla MRI was used to detect compressing vessels or concomitant lesions near the root entry zone (REZ) of respective cranial nerves. All patients underwent microvascular decompression (MVD) by a single surgeon.

Surgical procedure

Under general anesthesia, the patient is placed in the lateral decubitus position or supine position and the eyes are taped shut after applying ointment to avoid corneal abrasion. We did not use neuromonitoring.

All patients underwent retrosigmoid lateral suboccipital approach under general anesthesia in the lateral decubitus or supine position with the side of the desired MVD placed up. The trunk and head are rotated slightly away to the contralateral side. The neck is flexed slightly to improve the surgeon's visibility along the caudo-rostral direction.

The skin incision made to expose the retromastoid area can be either linear or curved linear. In our surgical practice, we place a 6–8 cm linear incision behind the mastoid process along the hairline. The central point of the incision is located at the mastoid notch. The incision for TN is placed medial and upward to the incision for hemifacial spasm, because of the differences in the operative fields and optic axes. The scalp and the underlying posterior auricular and sternocleidomastoid muscles are cut. The occipital artery and other vessels in the fascia are coagulated and cut. The underlying muscles are cut sequentially. Small muscle graft (splenius capetis) about 5mm width and 1cm length was harvested. The bone window is made by craniotomy or craniectomy to expose the borders of the transverse and sigmoid sinuses and their junction. The asterion, mastoid tip, and orifices of the emissary veins are used as surface landmarks to predict the positions of the transverse and sigmoid junction. A curvilinear dural opening and reflecting toward sigmoid sinus. Cerebellar hemisphere is gently retracted to open arachnoid and drain CSF. Cerebellar surface is then covered with cottonoid on a rubber dam. Sharp dissection of arachnoid and identification of lower CN, 7th & 8th CN and 5th CN. Identification of offending vessels compressing REZ of 5th (Figure 1A), 7th and 9th CN. Separation of compressing vessel from CN and reposition of it using muscle in between these two structures (Figure 1B). The offending vessel was mobilized away from the root entry zone (REZ) of cranial nerves after arachnoid dissection. The muscle piece was then inserted in-between the offending blood vessel and REZ. We didn't not use fibrin glue or suture to fix the muscle. Watertight dural closure was achieved with or without autologous fascia and continuous suturing was done using 4-0 vicryl round body suturing material. In case of craniotomy, bone flap was replaced and fixed with titanium plates. Wound closure in anatomical layers i.e: continuous suturing of muscle layer s, fascial suturing if preserved, subcutaneous interrupted suturing and final skin suturing was done.

Illustrative cases

Case 1: A 45-year-old female complained of sharp electrifying right facial pain for 3 years. On examination, she had V2 and V3 neuralgic pain. MRI findings correlated with the symptoms, i.e, vascular loop at root entry zone (REZ) of fifth cranial nerve. After 3 years of refractory pain to medications, the patient underwent microvascular decompression. On surgical field, superior cerebral artery was found as a vascular loop at REZ which was mobilized after cutting the surrounding arachnoid (Figure 1A). Small muscle graft was placed between the offending artery and the fifth cranial nerve (Figure 1B). The patient was pain free after surgery and discharged on the seventh day of surgery.

Case 2: A 51-year-old female with left sided throat pain radiating to the postauricular region which was episodic and sharp since 3 years. Patient also had difficulty swallowing for 3 years, loss of appetite due to pain for 3 months and not responding to medication. MRI did not show any particular offender. The patient underwent microvascular decompression, the offender was seen and separated from the 9th cranial nerve with muscle graft but the offending vessel could not be particularly identified (Figure 1C). Small muscle graft was placed between the offending artery and the 9th cranial nerve (Figure 1D). The post-operative period was uneventful and the patient had complete pain relief.

Results

Patients were classified into five age groups as shown in Table 1 and basic characteristics are highlighted in Table 2. Among 26 patients, 10 patients (38.46%) were male and 16 patients (61.53%) were female. TN was on the right side in 14, left side on 8; HFS was on the right side in 1 and left side on 2; GPN was on left side in 1 patient.

Of the 22 patients with TN, 20 (90.90%) were pain-free immediately after surgery, one patient experienced residual pain, although the intensity of the pain was reduced markedly. The patient was kept under low dose carbamazepine. The remaining one patient developed recurrent trigeminal neuralgia, therefore underwent second surgery after 3 years of first surgery. The surgical field in this patient showed no adhesions and the re-surgery alleviated the pain greatly. Among three cases of hemifacial spasm, two had complete relief of spasm following MVD and one had partial relief. One case of GPN completely recovered following surgery.

Neurovascular compression was found in all patients, and the causative vessel was identified as a single artery than multiple arteries. The most common offending vessel was the SCA for TN, AICA loop for HFS, a PICA loop causing GPN, followed by multiple arteries in 3 cases of TN, and unknown cause in 1 patient of TN.

A coexisting tumor, a lipoma was detected during MVD in one patient, in whom transposition of the causative vessel was performed. The lipoma was not removed even though it was close to REZ of trigeminal. The neuralgic pain was resolved immediately after surgery. In one case of TN, vestibular schwannoma was removed with MVD and the patient was post-surgery pain free. In two patients with a petrosal meningioma detected on a diagnostic MRI, the tumor was totally removed, in addition to MVD.

Given that the neuralgic pain disappeared completely after MVD, the tumor per se did not seem to have been the cause of the pain.

Post-operative clinical findings showed no neurological deficit. Three patients with TN had hyposthesia around trigeminal nerve distribution. Three patients developed pseudomeningocele, thus lumbar drain was placed for at least seven days. One patient with TN developed features of meningitis, and was treated accordingly. House-Brackmann grade 2 facial palsy was seen post-operatively in a patient with HFS, with complete remission on 6 months follow-up. On long term follow-up on which average follow-up period being 72 months, the patients were either seen in the out-patient department or heard over the phone.

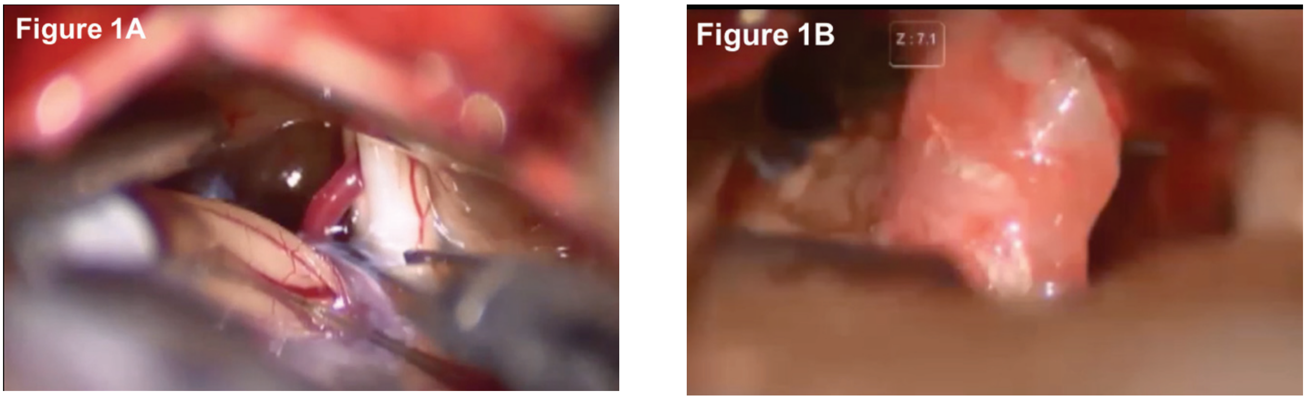

Figure 1A: Intraoperative picture showing SCA loop as offender to 5th CN. B: A muscle graft is used as an interposing material in-between SCA loop and 5th CN.

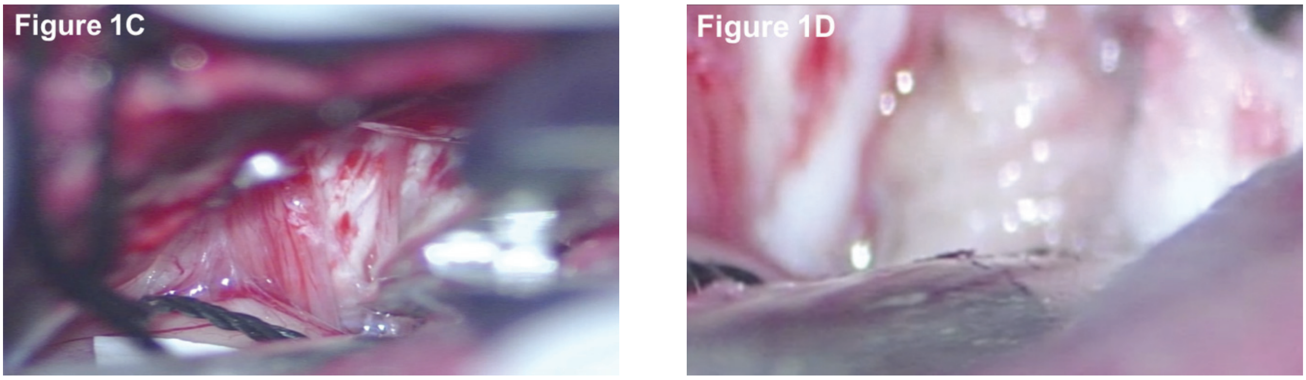

Figure 1C: Unknown offender over 9th CN seen intra-operatively in patient with GPN. Figure 1D: Muscle patch being placed after separating the offending artery from 9th CN.

Age distribution	Number	Percentage
31-40	6	23.08%
41-50	5	19.23%
51-60	9	34.62%
61-70	5	19.23%
71-80	1	3.85%
Total	**26**	

Table 1: Age wise patient group

Pathology	Distribution	No. of patient
Trigeminal Neuralgia	V2	4
	V3	11
	V2-3	4
	V1,2 and 3	3
Hemifacial Spasm	Orbicularis oculi	1
	Orbicularis oculi and oris	2
Glossopharyngeal Neuralgia	Throat and posteriorly on submandibular	1
	Offending vessels	
Trigeminal Neuralgia	SCA	9
	AICA	1
	Veins	2
	Unidentified vessels	3
	CP angle tumors	4
	No cause	3
Hemifacial Spasm	AICA loop	3
Glossopharyngeal Neuralgia	PICA loop	1
Laterality		
Trigeminal neuralgia		
Right	14	
Left	8	
Hemifacial spasm		
Right	1	
Left	2	
Glossopharyngeal Neuralgia		
left	1	

Table 2: Baseline characteristics of 26 patients

Discussion

Medical treatment is first line therapy and is often highly effective. Microvascular decompression (MVD) is considered first line surgical treatment for patients with medically intractable neuralgic pain and facial spasms. Improved anatomical knowledge, microsurgical and anaesthetic techniques have now made MVD safer and more effective than in previous decades. It has higher rates of complete pain alleviation and lower rates of post-operative complications.

Sindou *et al.*[4] reported 362 adults with TN reported 81% successful outcome 1 year after MVD. Similarly, Bender *et al.*[5] reported a good outcome in 83% of their patients. In our series, 20 (90.91%) out of 22 patients with TN had complete pain relief, whereas, one patient had partial pain needing medication and another had recurrence needing re-exploration. For refractory neuralgic pain, MVD is the first line treatment till date due to higher success rate.[6] Samii *et al.*[7] found that among 117 HFS patients who underwent MVD, 59% were spasm free at the time of discharge and 91% experienced no symptoms during a mean follow-up duration of 9.4 years. In our series, 2 out of 3 patients had complete spasm relief following MVD and one patient had partial improvement. For refractory facial spasm, MVD has shown to be a first line treatment.

Since MVD is an accepted technique for more than 2 decades, there have been several modifications and elaborations to the technique, particularly in the method of maintaining the separation of the nerve and the offending vessel. The autologous muscle graft, fascia or various other prosthesis are used to interpose or transpose the offending vessels. Several reports have shown that during the transposition techniques, there is a higher amount of blood loss due to the bleeding from venous channels during tentorial dissection. The transposition or sling method could be dangerous, especially when dealing with the anteroinferior cerebellar artery (AICA), which generally has important perforators to the brainstem as well as the labyrinthine artery arising from its cisternal segment.[8]

Some authors have recently advocated alternative techniques such as the “hanging or sling technique”, where the offending vessel is transposed from the nerve by using strips of autologous tissue or polytetrafluoroethylene belt or fenestrated clips for aneurysm clips. [8] But some authors believe that the increased exposure needed for the sling techniques increased the potential complications of hearing loss and facial paresis and did not recommend its routine use.[9, 10]

There are various factors leading to the recurrence of symptoms after MVD i.e. vascular variations, type of offender, materials used or techniques used. After performing 132 second surgeries, Barker et al. [11] later reported either veins or small arteries to be the compressing vessels most frequently found in the second surgery. As the recurrence rate is negligible in our case series, we highly speculate that the role of interposing material is of utmost importance for the possibility of re-exploration.

The five years' retrospective study by Jagannath PM et al, using autologous muscle graft as an interposition material in 180 patients gained good results with practically no serious graft related complications. The study also demonstrated recurrence in 19 patients with re-exploration where there was no usual perineural adhesions and muscle graft being intact but smaller in size.[12] Hassan H et al;[13] reported 65 patients with prognostic impact related to the interposing material used. The series reported a negligible recurrence rate of 5% with muscle graft when compared to a high rate of recurrence with Teflon interposition i.e. 40%. This study also favors the use of autologous muscle graft rather than prosthesis. In another large case series where studies were done to explore the cause of recurrence, on reoperation, Teflon compression or adhesions was seen in 13% cases to be the causes of recurrence.[14]

Though Teflon is a popular material used in many centers due to its relative inertness, several reports with complications like granuloma formation and chemical meningitis are known. Teflon granuloma after MVD for hemifacial spasm is quite rare. There are only two publications about Teflon granuloma after MVD for hemifacial spasm. One was reported by Megerian et al.[15] in 1995, and the other was reported by Deep et al.[16] in 2016. An excessive number of Teflon pieces needed to achieve proper decompression may cause Teflon granulomas, known to cause iatrogenic irritation of the lower cranial nerves.[17] The histopathology of Teflon granuloma has been reported previously; Dedo et al.[18] reported it as a foreign body reaction consisting of many multinuclear giant cells surrounding intracytoplasmic Teflon particles with hyalinized scar tissue and focal hemosiderin deposition. Matsushima et al.[19] found that in all of their 63 explored cases, adhesion of the Teflon to the nerve was felt to be responsible.

Conceptually, the use of muscle arises from the idea that an autologous material should be safer and better tolerated than a synthetic prosthesis. The use of muscle as an interposing material seemed to be safe and cost effective with negligible recurrence rate in our series along with many other reported studies. As reported by Jagannath PM et al,[12] the only concern with the use of muscle as interposing material is graft wasting with time. Our series showed no iatrogenic irritation of the cranial nerves, and we consider that this was mainly because of the interposition technique, with the use of autologous muscle pieces.

Conclusion

According to our study, the use of autologous muscle graft as an interposing material in MVD seemed to be safer with less recurrence rate, technically feasible and cost effective. Further work like randomized controlled trials are needed to prove the superiority of autologous muscle graft as an interposing material compared to others.

Conflict of Interest: None

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