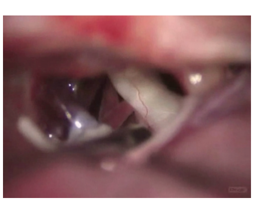
Use of the Arachnoid Membrane of the Cerebellopontine Angle to Transpose the Superior Cerebellar Artery in Microvascular Decompression for Trigeminal Neuralgia: Technical Note

Miran Skrap, MD
Department of Neurosurgery,
Azienda Ospedaliero Universitaria di Udine,
Udine, Italy

Francesco Tuniz, MD
Department of Neurosurgery,
Azienda Ospedaliero Universitaria di Udine,
Udine, Italy

Reprint requests:
Francesco Tuniz, MD,
Department of Neurosurgery,
Azienda Ospedaliero Universitaria di Udine,
Piazzale S.Maria della Misericordia,
Pad. N°4,
33100, Udine, Italy.
E-mail: tuniz.francesco@gmail.com

Received, April 1, 2009.
Accepted, December 8, 2009.



ONLINE DIGITAL VIDEO

BACKGROUND: Microvascular decompression is an accepted, safe, and useful surgical technique for the treatment of trigeminal neuralgia. Autologous muscle or implant materials such as shredded Teflon are used to separate the vessel from the nerve but may occasionally be inadequate, become displaced or create adhesions and recurrent pain.

OBJECTIVE: The authors evaluated the use of arachnoid membrane of the cerebellopontine angle to maintain the transposition of vessels from the trigeminal nerve.

METHODS: The authors conducted a retrospective review of microvascular decompression operations in which the offending vessel was transposed and then retained by the arachnoid membrane of the cerebellopontine cistern, specifically by the lateral pontomesenchepalic membrane.

RESULTS: This technique was used in 30 patients of the most recently operated series. Postoperatively, complete pain relief was achieved in 90% of the patients without any observed surgical complications.

CONCLUSION: To the authors' knowledge this is the first report in which the arachnoid membrane is used in the microvascular decompression of the trigeminal nerve. While this technique can be used only for selected cases, the majority of the vascular compressions on the trigeminal nerve are due to the SCA, so this sling transposition technique can be useful and effective.

KEY WORDS: Arachnoidal membrane, Microvascular decompression, Trigeminal neuralgia

Neurosurgery 66[ONS Suppl 1]:ons88-ons91, 2010 DOI: 10.1227/01.NEU.0000367556.35258.FA

Vascular arterial contacts with the dorsal root of the trigeminal nerve were first described in 1929 by Dandy.[1] The concept of microvascular decompression (MVD) surgery was first introduced by Jannetta[1a] and has since become adopted as an effective treatment for trigeminal neuralgia (TN) and hemifacial spasm (HFS). Currently, MVD is considered to be the surgical treatment of choice for intractable TN due to vascular compression.[2-6] The aim of microdecompressive surgery is to eliminate vascular compression on the trigeminal nerve. This is commonly achieved by interposition of autologous (muscle, periosteum, fascia) or soft prosthesic material (shredded Teflon felt, Gelfoam, Dacron sponge, Ivalon sponge, cotton) after mobilization of the offending vessel.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.neurosurgery-online.com).

This is an anatomic operative study conducted on 30 recent MVD for TN. Observing the relationships between different anatomic structures of the cerebellopontine angle, the senior author (M.S.) noted the possibility of using some anatomic structures of the angle, such as arachnoid membrane or the superior petrosal venous complex, to sequester the offending vessel from the trigeminal nerve in selected cases.

This transposition technique avoids direct contact between prosthetic material and the trigeminal nerve. The authors acknowledge that the arachnoidal membrane cannot be used in all cases. First, we must consider the pontomesenchepalic arachnoidal membrane or the location of the petrosal venous complex. Both are on the superior part of the trigeminal nerve; thus, they can be used only for vessels which may be shifted along the superior part of the nerve. Consequently, the superior cerebellar artery (SCA) (and its branches), which is primarily responsible for the conflict, is the only artery in which this technique is possible.

Anatomic Background

The anatomic structures that play an important role in this transposition technique are the trigeminal nerve, the arachnoid membrane of the cerebellopontine angle (most commonly the lateral pontomesencephalic membrane), the arterial vessels compressing the trigeminal nerve, and the petrosal venous complex. The cerebellopontine cistern is separated from the ambient cistern by the lateral pontomesencephalic membrane. This membrane is attached to the brainstem at the junction of the midbrain and pons and to the outer arachnoidal membrane near the free edge of the tentorium and spans the interval between the posterior cerebral artery (PCA) and SCA.[7] The most common vessel found compressing the trigeminal nerve in different surgical series of MVD is a rostroventral superior cerebellar artery loop, which compresses the trigeminal nerve either at the root entry zone or distally. The SCA enters the cerebellopontine cistern by passing through the junction of the anterior pontine membrane and the oculomotor nerve, courses below the trochlear nerve and the lateral pontomesencephalic membrane, and above the trigeminal nerve in its passage through this cistern.[8] The anterior pontine membrane separates the cerebellopontine and prepontine cisterns. This membrane crosses the interval between the pons and the outer arachnoid membrane that rests on the clivus, intersects the oculomotor nerve superiorly, and extends downward along the medial side of the abducens nerve.[7,9]

The anterior inferior cerebellar artery (AICA) enters the lower part of the cerebellopontine cisterns by passing through or below the anterior pontine membrane. This anatomic configuration only allows the SCA to be sequestered with the help of the arachnoid.

PATIENTS AND METHODS

Patient Population

Between 1990 and 2006, 156 patients affected by TN underwent microvascular decompression performed by the senior author (M.S.); 90% of the patients were affected by typical TN. Seven patients, all with typical neuralgia, underwent reoperated for pain recurrence.

The arachnoidal transposition technique was used in the recent series, but not in all cases. Since we started this option, we have been able to use this technique in 30 of 47 surgical procedures.

Surgical Technique

A classical surgical retrosigmoid approach, as described in the literature,[1,10] with some insignificant modifications, has been used. When approaching the trigeminal nerve, care is taken to spare the lateral pontomesenchepalic membrane and to preserve and better dissect the petrosal venous complex. The only vessel fit for this technique is the superior cerebellar artery or its distal branches. The arachnoidal membrane or the petrosal veins are positioned superiorly and medially to the nerve. Consequently, we may only lift up the vessel.

A long fissure is made in the arachnoidal membrane to allow the artery to pass through and move away from the nerve. (see Video 1, Supplemental Digital Content 1, http://links.lww.com/NEU/A274). Considering that the artery has an arch-shaped course, we must elevate it without kinking or stretching it. Furthermore, we did not find small branches which would limit the motion of the artery in this part of the SCA. In very few cases, we observed a slight spasm because of the manipulation. A few drops of papaverin were sufficient to solve the spasm, keeping the vessel in the new position. Alternatively, the culprit vessel can be passed behind and above the petrosal venous complex to solve the neurovascular compression. (see Video 2, Supplemental Digital Content 2, http://links.lww.com/NEU/A275). Following transposition of the vessel with the arachnoidal membrane, a small piece of muscle or shredded Teflon may be positioned between the artery and arachnoidal membrane or vein to better guarantee the new position, avoiding any direct contact between the prosthesis and nerve root. (see Video 3, Supplemental Digital Content 3, http://links.lww.com/NEU/A276).

Twelve out of 30 patients in this series had Teflon or muscle used in addition to the technique described. The primary reason making this technique impossible has been the deficiency of the membrane, particularly a combination between a long artery and short nerve with a consequent high risk of kinking in the case of mobilizing the artery in a narrow space.

RESULTS

The arachnoidal transposition technique was used in 30 cases, all with typical TN. In the cases in which this technique was used, it is obvious that a very significant compression of the nerve due to the SCA was present. None of the patients exhibited a new neurological deficit after surgery. The immediate postoperative pain relief of this series was 100%; at 2 years, 1 patient required drugs to remain pain free.

DISCUSSION

MVD has been widely used and demonstrated as a safe and effective method in treating typical TN, with the operative outcomes varying in different reports.[11-14] The institution at which the surgery is performed and the expertise of the surgeon are crucial for this surgery to achieve a high degree of safety. Barker et al[11] reported that most cases of TN recurrence occurred in the first 2 years after surgery, and incidence of significant recurrence is reported to vary from 3% to 30% due to several causes, including how precisely the cisternal portion of the trigeminal nerve could be observed, how completely all offending vessels including veins could be decompressed, what kind of implant was used, and/or what kind of technique was utilized for the transposition of the culprit arteries at the first operation. Incomplete vascular decompression is thought by some to be an important and frequent cause of failure.[10,15] However, recurrent vascular compression has also occurred after decomposition of an absorbable implant, such as muscle or Gelfoam, slippage of a synthetic implant, or adhesions of the Teflon felt to the nerve. Different sling techniques have been used in MVD, in which several materials have been used, including Teflon felt, Dacron sponge, Ivalon sponge, cotton, periosteum muscle, fascia, Gore-Tex pad, and fenestrated aneurysm clips.[5,6,16-19] These materials may cause side effects that evolve into recurrent TN.[20-23] It is now well known that a muscle piece alone can be inadequate due to atrophy 3 years or more after MVD.[18,24] Teflon felt is currently the material of choice for most neurosurgeons. This is due to its characteristics: (1) it is well tolerated by the body; (2) it is not reabsorbed; and (3) it has a lower complication rate compared with other materials. In these cases, the major complications are inflammatory foreign-body reactions. Teflon felt may cause thick, severe adhesion and granulomatous formations. The time necessary for Teflon felt to cause a fibrotic change ranges from 10 months to 5 years.[24,25] These facts suggest that using any kind of implant in the interposing technique may cause adhesion of the inserted materials to the trigeminal nerve. Therefore, avoiding the contact of the prosthetic material with the trigeminal nerve or a sling retraction technique are recommended for the initial MVD for TN.

Even if the MVD is a well established procedure, there are still debates on the techniques to obtain decompression and on the materials used to allow it. Recently, Sindou et al[15,26] provided evidence regarding how MVD should be performed by using a noncompressive technique, signaling how the presence of prosthetic material in contact with the trigeminal root should be a negative prognostic factor.

Some authors claim the MVD procedure could work through a lesioning mechanism and that it's possible that an inflammatory response to the foreign body could be part of the reason for the pain relief acting as a lesioning mechanism.[27,28] In our experience of reoperations limited to 7 cases, we found strong adhesions of the shredded Teflon felt with the trigeminal nerve. In all cases, we removed the Teflon and freed the nerve. Six of the 7 patients improved after the procedure. This finding has been the major cause of these recurrences.

The goal of this surgery is to hold the offending vessel away from the trigeminal nerve root and maintain this transposition without side effects. The key points of this surgical procedure are some anatomic conditions: the presence of a useful arachnoid membrane, a proper combination between the length of the SCA and the trigeminal nerve, and a favorable conformation of the petrous vein (Fig. 1). We need some space to lift the artery and leave it in a new position, avoiding kinking. In our cases, we never found small branches that prevented this mobilization. At this point, we are able to put some muscle or even a small piece of Teflon between the artery and the arachnoid membrane to ensure the new position of the vessel far from the nerve.

We see several advantages in using this technique. There is no need for any type of prosthesis to be placed in contact with the nerve, no need for sutures to secure the prosthesis to the dura mater, and no risk of inflammatory foreign-body reactions. We are aware that this technique cannot be used for any type of neurovascular compressions and that it is a useful tool only for the transposition of the SCA and its branches. In our experience, this technique has shown good clinical outcome with no evidence of surgical complications.

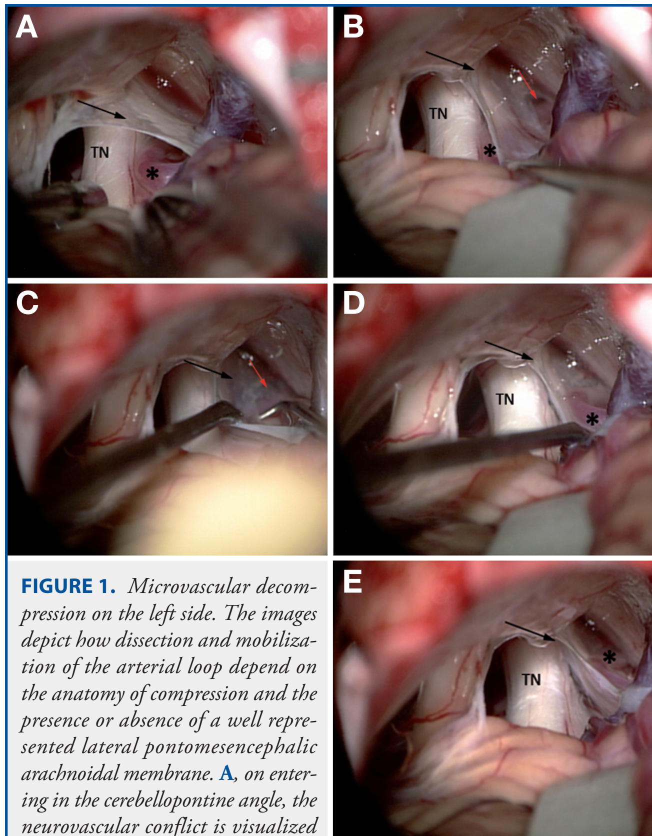


FIGURE 1. *Microvascular decompression on the left side. The images depict how dissection and mobilization of the arterial loop depend on the anatomy of compression and the presence or absence of a well represented lateral pontomesencephalic arachnoidal membrane.* **A***, on entering in the cerebellopontine angle, the neurovascular conflict is visualized and care must be taken to preserve the lateral pontomesencephalic arachnoidal membrane (black arrow).* **B***, the membrane is opened "buttonhole-like" (red arrow)* **C***, the SCA (asterisk) is passed through the hole.* **D***, the vessel is transposed from the trigeminal nerve (TN). E, at the end of the procedure, some muscle or a piece of Teflon could be positioned to ensure the new position of the SCA.*

This technique implies the presence of a clear conflict with SCA or its branches, and we know that an evident conflict is clearly a good predictive factor for an optimal outcome.

CONCLUSIONS

Different sling techniques have been described for TN, in which several materials have been used. Our proposal is a natural sling technique without the aid of any prosthesis. We are aware that this technique can be used only for selected cases. However, considering that the majority of the vascular compressions on the trigeminal nerve are due to the SCA, this sling transposition technique can be useful and effective. Our experience suggests that approaching the cerebellopontine angle for TN is important to search for the anatomic conditions that can allow the surgeon to use this natural transposition technique.

Acknowledgments

We thank Steven Tenn, PhD, for the help with the edits and Alex Paiani, NP, for the help with the videos.

REFERENCES

1. Dandy WE. The treatment of trigeminal neuralgia by the cerebellar route. *Ann Surg*. 1932; 96(4):787-795.
1a. Jannetta PJ. Arterial compression of the trigeminal nerve at the pons in patients with trigeminal neuralgia. *J Neurosurg.* 1967;26(1):Suppl:159-162.
2. Barker FG 2nd, Jannetta PJ, Bissonette DJ, Shields PT, Larkins MV, Jho HD. Microvascular decompression for hemifacial spasm. *J Neurosurg.* 1995;82(2):201-210.
3. Bejjani GK, Sekhar LN. Repositioning of the vertebral artery as treatment for neurovascular compression syndromes. Technical note. *J Neurosurg.* 1997;86(4):728-732.
4. Kalkanis SN, Eskandar EN, Carter BS, Barker FG 2nd. Microvascular decompression surgery in the United States, 1996 to 2000: mortality rates, morbidity rates, and the effects of hospital and surgeon volumes. *Neurosurgery.* 2003;52(6):1251-1262.
5. Kyoshima K, Watanabe A, Toba Y, Nitta J, Muraoka S, Kobayashi S. Anchoring method for hemifacial spasm associated with vertebral artery: technical note. *Neurosurgery.* 1999;45(6):1487-1491.
6. Tomasello F, Alafaci C, Salpietro FM, Longo M. Bulbar compression by an ectatic vertebral artery: a novel neurovascular construct relieved by microsurgical decompression. *Neurosurgery.* 2005;56(1 Suppl):117-124.
7. Rhoton AL Jr. The posterior fossa cisterns. *Neurosurgery.* 2000;47(3 Suppl):S287-S297.
8. Hardy DG, Rhoton AL Jr. Microsurgical relationships of the superior cerebellar artery and the trigeminal nerve. *J Neurosurg.* 1978;49(5):669-678.
9. Matsushima T, Rhoton AL Jr, de Oliveira E, Peace D. Microsurgical anatomy of the veins of the posterior fossa. *J Neurosurg.* 1983;59(1):63-105.
10. McLaughlin MR, Jannetta PJ, Clyde BL, Subach BR, Comey CH, Resnick DK. Microvascular decompression of cranial nerves: lessons learned after 4400 operations. *J Neurosurg.* 1999;90(1):1-8.
11. Barker FG 2nd, Jannetta PJ, Bissonette DJ, Larkins MV, Jho HD. The long-term outcome of microvascular decompression for trigeminal neuralgia. *N Engl J Med.* 1996;334(17):1077-1083.
12. Broggi G, Ferroli P, Franzini A, Servello D, Dones I. Microvascular decompression for trigeminal neuralgia: comments on a series of 250 cases, including 10 patients with multiple sclerosis. *J Neurol Neurosurg Psychiatry.* 2000;68(1):59-64.
13. Sindou M, Leston J, Howeidy T, Decullier E, Chapuis F. Micro-vascular decompression for primary Trigeminal Neuralgia (typical or atypical). Long-term effectiveness on pain; prospective study with survival analysis in a consecutive series of 362 patients. *Acta Neurochir (Wien).* 2006;148(12):1235-1245.
14. Miller JP, Magill ST, Acar F, Burchiel KJ. Predictors of long-term success after microvascular decompression for trigeminal neuralgia. *J Neurosurg.* 2009;110(4):620-626.
15. Sindou M, Howeidy T, Acevedo G. Anatomical observations during microvascular decompression for idiopathic trigeminal neuralgia (with correlations between topography of pain and site of the neurovascular conflict). Prospective study in a series of 579 patients. *Acta Neurochir (Wien).* 2002;144(1):1-13.
16. Attabib N, Kaufmann AM. Use of fenestrated aneurysm clips in microvascular decompression surgery. Technical note and case series. *J Neurosurg.* 2007;106(5):929-931.
17. Laws ER Jr, Kelly PJ, Sundt TM Jr. Clip-grafts in microvascular decompression of the posterior fossa. Technical note. *J Neurosurg.* 1986;64(4):679-681.
18. Melvill RL, Baxter BL. A tentorial sling in microvascular decompression for trigeminal neuralgia. Technical note. *J Neurosurg.* 1996;84(1):127-128.
19. Shigeno T, Kumai J, Endo M, Oya S, Hotta S. Snare technique of vascular transposition for microvascular decompression–technical note. *Neurol Med Chir (Tokyo).* 2002;42(4):184-190.
20. Chen J, Lee S, Lui T, Yeh Y, Chen T, Tzaan W. Teflon granuloma after microvascular decompression for trigeminal neuralgia. *Surg Neurol.* 2000;53(3):281-287.
21. Matsushima T, Yamaguchi T, Inoue TK, Matsukado K, Fukui M. Recurrent trigeminal neuralgia after microvascular decompression using an interposing technique. Teflon felt adhesion and the sling retraction technique. *Acta Neurochir (Wien).* 2000;142(5):557-561.
22. Cho DY, Chang CG, Wang YC, Wang FH, Shen CC, Yang DY. Repeat operations in failed microvascular decompression for trigeminal neuralgia. *Neurosurgery.* 1994;35(4):665-670.
23. Kureshi SA, Wilkins RH. Posterior fossa reexploration for persistent or recurrent trigeminal neuralgia or hemifacial spasm: surgical findings and therapeutic implications. *Neurosurgery.* 1998;43(5):1111-1117.
24. Lovely TJ, Jannetta PJ. Microvascular decompression for trigeminal neuralgia. Surgical technique and long-term results. *Neurosurg Clin N Am.* 1997;8(1):11-29.
25. Premsagar IC, Moss T, Coakham HB. Teflon-induced granuloma following treatment of trigeminal neuralgia by microvascular decompression. Report of two cases. *J Neurosurg.* 1997;87(3):454-457.
26. Sindou M, Leston JM, Decullier E, Chapuis F. Microvascular decompression for trigeminal neuralgia: the importance of a noncompressive technique–Kaplan-Meier analysis in a consecutive series of 330 patients. *Neurosurgery.* 2008;63(4 Suppl 2):341-351.
27. Adams CB. Microvascular compression: an alternative view and hypothesis. *J Neurosurg.* 1989;70(1):1-12.
28. Monstad P. Microvascular decompression as a treatment for cranial nerve hyperactive dysfunction–a critical view. *Acta Neurol Scand Suppl.* 2007;187:30-33.

Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

***Supplemental digital content** is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.neurosurgery-online.com).*