Microvascular Decompression for Treatment of Trigeminal Neuralgia, Hemifacial Spasm, and Glossopharyngeal Neuralgia: Three Surgical Approach Variations: Technical Note

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Received, January 16, 2003.
Accepted, August 12, 2003.

OBJECTIVE: We have used three different approaches, namely, the infratentorial lateral supracerebellar approach, the lateral suboccipital infrafloccular approach, and the transcondylar fossa approach, for microvascular decompression for treatment of trigeminal neuralgia, hemifacial spasm, and glossopharyngeal neuralgia, respectively. Each approach is a variation of the lateral suboccipital approach to the cerebellopontine angle (CPA); however, each has a different site of bony opening, a different surgical direction, and a different route along the cerebellar surface.

METHODS: The infratentorial lateral supracerebellar approach is used to access the trigeminal nerve in the superior portion of the CPA through the lateral aspect of the cerebellar tentorial surface. The lateral suboccipital infrafloccular approach is directed through the inferior part of the cerebellar petrosal surface to reach the root exit zone of the facial nerve below the flocculus. The transcondylar fossa approach is used to access the glossopharyngeal nerve in the inferior portion of the CPA through the cerebellar suboccipital surface, after extradural removal of the jugular tubercle as necessary.

RESULTS: In all three approaches, the cerebellar petrosal surface is never retracted transversely, that is, the cerebellar retraction is never directed parallel to the longitudinal axis of the VIIIth cranial nerve, dramatically reducing the risk of postoperative hearing loss.

CONCLUSION: The greatest advantage of the differential selection of the surgical approach is increased ability to reach the destination in the CPA accurately, with minimal risk of postoperative cranial nerve palsy.

KEY WORDS: Infratentorial lateral supracerebellar approach, Lateral suboccipital infrafloccular approach, Microvascular decompression, Transcondylar fossa approach

Neurosurgery 53:1436-1443, 2003 DOI: 10.1227/01.NEU.0000093431.43456.3B www.neurosurgery-online.com

Trigeminal neuralgia (TN), hemifacial spasm (HFS), and glossopharyngeal neuralgia (GPN), categorized as hyperactive cranial nerve dysfunction syndrome by Jannetta (5), are symptoms caused by vascular compression at the root entry or exit zone of the cranial nerves (4–6, 8). Microvascular decompression (MVD) via the lateral suboccipital approach is now widely performed as the preferred method for treating TN, HFS, and GPN (1, 7, 21–23). The goal of MVD for treatment of these disorders is complete alleviation of the symptoms with minimization of surgical complications. To achieve this, we have modified the lateral suboccipital approach in accordance with the level of the lesion in the cerebellopontine angle (CPA), and we have adopted three variations of surgical access, namely, the infratentorial lateral supracerebellar approach for treatment of TN, the lateral suboccipital infrafloccular approach for treatment of HFS, and the transcondylar fossa approach for treatment of GPN (11–14, 18). In this report, we describe the operative procedures for the three variations and clarify their surgical characteristics and differences.

SURGICAL PROCEDURES

Basic Concept of Three Variations of MVD Based on Anatomic Features

For good orientation of the neurovascular structures in the CPA, Rhoton and colleagues (3, 9, 10, 19) divided the CPA into three portions (i.e., superior, middle, and inferior) and explained their anatomic relationships with the "rule of 3." This concept includes three foramina (Meckel's cavity, internal acoustic meatus, and jugular foramen), three groups of cranial nerves (trigeminal nerve, facial and vestibulocochlear nerves, and glossopharyngeal, vagal, and accessory nerves), three cerebellar arteries (superior cerebellar artery [SCA], anteroinferior cerebellar artery [AICA], and posteroinferior cerebellar artery [PICA]), and three cerebellar surfaces (tentorial surface, petrosal surface, and suboccipital surface). These groups of neurovasculo-osseous structures correspond well with each other, and the rule of 3 allows us to choose an anatomically appropriate route to the destination in the CPA (14, 16).

In cases of TN, the lateral mesencephalic segment of the SCA usually courses medial to the trigeminal nerve and compresses the nerve from a rostromedial direction (3). The trigeminal nerve is thus clearly visible when approached from the tentorial cerebellar surface, rather than the petrosal surface, as facilitated with the infratentorial lateral supracerebellar approach (11). For MVD to treat HFS, the surgical route to the facial nerve must proceed through the petrosal cerebellar surface (*Fig. 1*). The root exit zone of the facial nerve is located immediately medial to the VIIIth cranial nerve in the supraolivary fossette, and the flocculus exists just lateral to the nerves. Therefore, with a direct approach in a dorsoventral direction, it is difficult to obtain complete observation of the facial nerve exit zone over the VIIIth cranial nerve and the flocculus. To avoid postoperative loss of auditory function, cerebellar retraction should be performed in a direction perpendicular to the VIIIth cranial nerve, not longitudinal to the nerve. The lateral suboccipital infrafloccular approach provides a safe precise surgical route from the caudolateral direction through the inferior part of the petrosal cerebellar surface to reach the facial nerve exit zone between the IXth cranial nerve and the flocculus, with retraction of the flocculus in a caudorostral direction (13, 16). For MVD treatment of GPN, we have adopted the transcondylar fossa approach, which provides a short direct surgical route from a caudal direction through the suboccipital cerebellar surface and provides wide exposure of the glossopharyngeal nerve, the vertebral artery, and the PICA (12, 17). These three approaches never require cerebellar retraction in a direction longitudinal to the VIIIth cranial nerve; therefore, postoperative hearing loss, although mild, was a rare occurrence in our series (2, 12, 20).

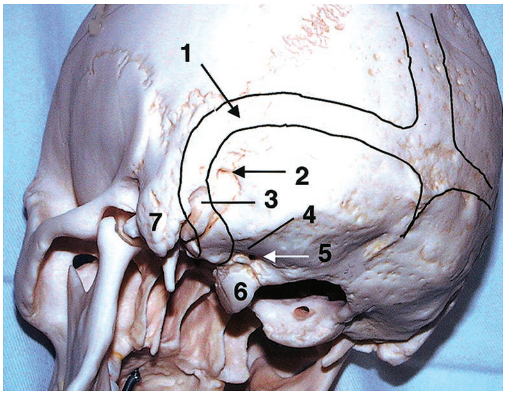

FIGURE 1. *Anatomic landmarks on the cranium. The asterion (1) is situated around the junction of the transverse and sigmoid sinuses and provides an estimate of the caudal border of the sinus. The initial bony opening should be made below this point for the infratentorial lateral supracerebellar approach for MVD for treatment of TN. The mastoid foramen (2), which conveys the mastoid emissary vein, indicates the posterior margin of the middle portion of the sigmoid sinus. The posterior end of the incisura mastoidea (3), located just behind the mastoid process (7), grossly corresponds to the level of the internal acoustic meatus. The bony opening for the infratentorial lateral supracerebellar approach should be made above this level, and the bony window for the lateral suboccipital infrafloccular approach for MVD for treatment of HFS should be opened below this level. The posterior condylar foramen (5) is opened extracranially at the condylar fossa (4), which is located just behind the occipital condyle (6). This foramen conveys the posterior condylar emissary vein communicating with the vertebral venous plexus and the inferior end of the sigmoid sinus or jugular bulb. In the transcondylar fossa approach for MVD for treatment of GPN, extradural drilling of the posterior part of the jugular tubercle, if necessary, can be performed along and above this foramen, which acts as a landmark.*

Infratentorial Lateral Supracerebellar Approach

The patient is placed in a lateral park bench position, and a vertical incision is made along and medial to the hairline (*Fig. 2A*). The craniotomy is performed high enough and lateral enough in the posterior fossa to expose an adequate length of the transverse sinus and the superior part of the sigmoid sinus (*Fig. 2B*). Anatomic landmarks on the calvarium include the

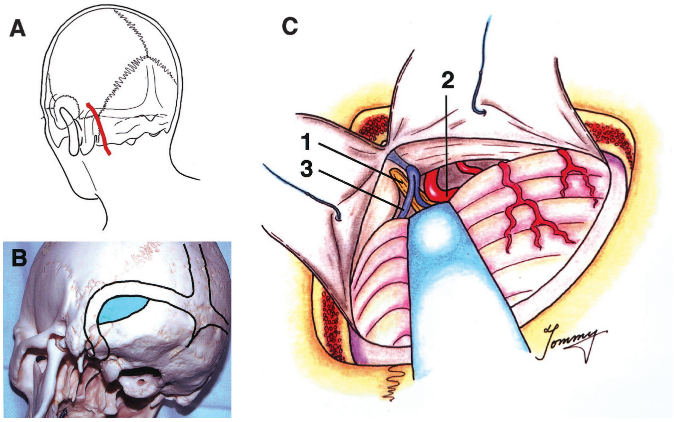

FIGURE 2. *Drawings illustrating the infratentorial lateral supracerebellar approach in MVD for treatment of TN.* A, *skin incision along and medial to the hairline in the retroauricular region.* B, *bony opening made in the superolateral portion of the posterior fossa, exposing the transverse sinus and the superior part of the sigmoid sinus above the posterior end of the incisura mastoidea.* C, *intraoperative view after cerebellar retraction in a caudorostral direction with a spatula placed over the lateral aspect of the tentorial cerebellar surface, showing the trigeminal nerve (1), which is located behind the SPV (3) and is compressed by the SCA (2) from the ventromedial side.*

asterion, the mastoid foramen, and the incisura mastoidea (*Fig. 1*). The key burr hole should be made on the asterion, which is located around the transverse sinus/sigmoid sinus junction. The mastoid foramen, which conveys the mastoid emissary vein, corresponds to the posterior margin of the middle portion of the sigmoid sinus. The incisura mastoidea is a palpable bony groove over the skin just behind the mastoid process, and the bony opening is usually made above the posterior end of the incisura mastoidea. After dural opening to obtain superolateral exposure of the posterior fossa, a spatula is placed over the lateral aspect of the tentorial cerebellar surface and is moved ventrally along the anterolateral margin of the cerebellar hemisphere until the tip is located close to the anterior angle. Minimal retraction in a caudorostral direction is necessary for observation of the superior petrosal vein (SPV), which is usually formed by the union of a few tributaries in an inverted-Y configuration. During cerebellar retraction, care should be taken to avoid injury to the hemispheric bridging veins on the tentorial surface, which drain into the tentorial sinus. After dissection of the arachnoid membrane, which is usually thick around the SPV and blocks the surgical view, the trigeminal nerve can be observed just ventromedial to the SPV (*Fig. 2C*). If necessary, a minimal number of bridging veins from the tentorial surface can be divided; however, the main trunk of the SPV draining from the petrosal cerebellar surface and the pons should be preserved. The most frequently offending artery is the SCA, which usually courses medial to the nerve and compresses it from the ventromedial side at several different points, because the lateral mesencephalic segment of the SCA bifurcates into rostral and caudal trunks when this segment compresses the nerve (*Fig. 3*) (11). Therefore, the arachnoid membrane must be dissected from the trigeminal nerve along its entire course from Meckel's cavity to the pons, for detection of arterial compression. The caudolateral surface of the trigeminal nerve, a rare site of AICA compression, can also be observed. For transposition of the compressing artery, we have frequently used the sling retraction technique (20). In this approach, the trigeminal nerve can be accessed without exposure of the petrosal cerebellar surface or the CPA cistern, and cerebellar retraction is performed on the tentorial surface in a caudorostral direction perpendicular to the VIIIth cranial nerve. Accordingly, the acoustic and facial nerves are never injured. Furthermore, this approach provides good observation of Meckel's cavity, where the SPV and the transverse pontine vein sometimes attach to the nerve. This venous compression would be either a concomitant or single cause of the neuralgia, and venous decompression would also be needed.

Lateral Suboccipital Infrafloccular Approach

The patient's position is the same as for the infratentorial lateral supracerebellar approach, except that the head position must be more vertex-down, for better exposure of the inferolateral part of the suboccipital region. The incision is also the same except caudally, where the inferior half of the incision is directed medially (*Fig. 4A*). The caudal part of the incision indicates the direction of the surgical access and provides space for insertion of the spatula after sectioning of the thick

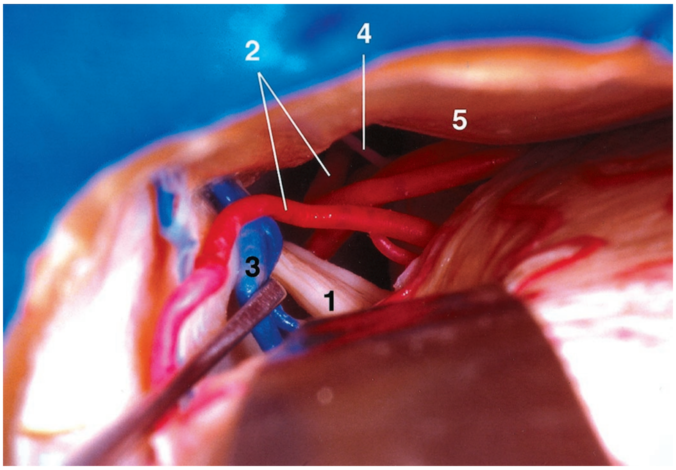

FIGURE 3. *Cadaveric specimen demonstrating an operative view of the infratentorial lateral supracerebellar approach. The trigeminal nerve* (1) *can be observed throughout its course from Meckel's cavity to the root entry zone near the pons. The most frequently offending artery is the SCA* (2), *which usually courses medial to the nerve and compresses it from the ventromedial side at several different points, because the lateral mesencephalic segment bifurcates into rostral and caudal trunks when this segment compresses the nerve. The SPV* (3) *usually blocks surgical access, but its main trunk draining from the cerebellar petrosal surface and the pons must be preserved.* 4, *trochlear nerve;* 5, *cerebellar tentorium.*

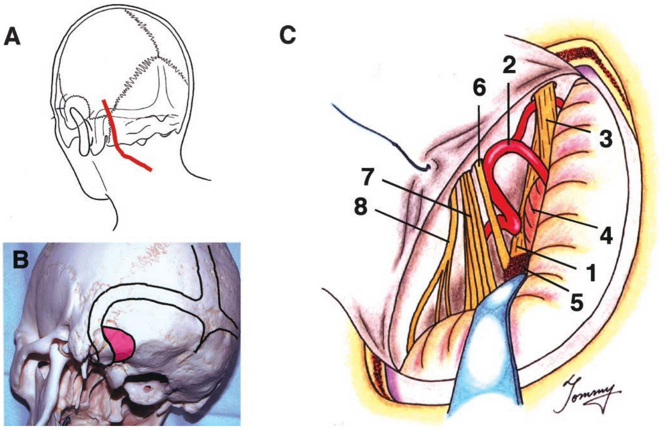

FIGURE 4. *Drawings illustrating the lateral suboccipital infrafloccular approach in MVD for treatment of HFS.* A, *caudal part of the skin incision directed medially toward the midline.* B, *bony opening made in the inferolateral portion of the posterior fossa, exposing the inferior part of the sigmoid sinus below the posterior end of the incisura mastoidea.* C, *intraoperative view after insertion of the spatula through the inferior aspect of the tentorial cerebellar surface, with its tip placed just on the choroid plexus* (5). *The root exit zone of the facial nerve* (1), *a common site of AICA* (2) *compression, can be clearly observed between the glossopharyngeal nerve* (6) *and the flocculus* (4). *The strict caudolateral direction of the surgical access allows good observation of the exit zone of the facial nerve separated from the vestibulocochlear nerve* (3). 7, *vagal nerve;* 8, *accessory nerve.*

nuchal muscles. Surgical access from a strictly caudal direction, which is one of the keys of this infrafloccular approach, requires the sectioning of more muscle and the skin incision mentioned above to yield an accurate surgical direction and space. The bony opening is made inferior and lateral in the posterior fossa, below the posterior end of the incisura mastoidea (*Fig. 4B*). It is important to achieve this inferolateral exposure slightly over the medial border of the inferior half of the sigmoid sinus. Additional bone removal as far lateral and caudal as the posterior condylar foramen would make surgical access much easier, with a minimal degree of cerebellar retraction after dural opening. Also, bony opening close to or up to the foramen magnum allows discharge of enough cerebrospinal fluid from the cisterna magna for relaxation of the cerebellum. Intradurally, the spatula should be placed first over the most inferior aspect of the petrosal cerebellar surface, to determine whether bridging veins exist around the jugular foramen. Excessive retraction should never be performed before the bridging veins are cut, to prevent potentially hazardous bleeding. Arachnoid membrane dissection around the jugular foramen to open the lateral aspect of the cerebellomedullary fissure allows observation of the IXth, Xth, and XIth cranial nerves and the flocculus with unforced cerebellar retraction. After dissection and separation of the arachnoid membrane between the IXth cranial nerve and the flocculus, the spatula can be inserted from the caudolateral direction through the inferior part of the petrosal surface, with the tip of the spatula being placed just on the choroid plexus from the foramen of Luschka (*Fig. 4C*). With gentle retraction of the flocculus in a caudorostral direction perpendicular to the VIIIth cranial nerve, the root exit zone of the facial nerve can easily be observed medial to the root entry zone of the VIIIth cranial nerve in the supraolivary fossette, which is located in the lateral aspect of the pontomedullary junction (*Fig. 5*). If the flocculus is too large to yield an adequate space, it can easily be dissected and folded medially, to allow complete observation. The caudolateral direction of access is the key to this approach, because it allows good observation of the root exit zone clearly separated from the VIIIth cranial nerve, with minimal cerebellar retraction. Indeed, the infrafloccular access can provide good exposure of the root exit zone, allowing observation of arterial compression from any direction, even a rostrodorsal direction (which is quite rare). The only site of arterial compression causing HFS is thought to be the root exit zone of the facial nerve (15). Therefore, it is not necessary to observe the other cisternal portions of the nerve, especially the part near the internal acoustic meatus, where excessive arachnoid membrane dissection would likely injure the small vessels from the AICA, including the internal auditory, subarcuate, and recurrent perforating arteries. Arachnoid membrane dissection around the nerve is important to prevent inadvertent traction; however, arachnoid membrane dissection around the internal acoustic meatus is practically unnecessary in this approach, because the VIIth and VIIIth nerves close to the meatus are never exposed and retraction would not reach this portion. In addition, we should bear in mind that the root exit zone of the facial nerve exists continuously lower in the pons, where the nerve fiber is covered with appropriate neural structures. The causative arteries, including the AICA, PICA, and/or vertebral artery, are mobilized and held away from the root exit zone with a minimal amount of prosthetic material. It is occasionally necessary to observe the root exit zone between the IXth and Xth cranial nerves. The patient undergoes auditory brainstem evoked potential monitoring during cerebellar retraction, and the retraction is released if there is any change on the monitor. The routine use of functional monitoring plays an important role in minimizing the complication of hearing loss, as commonly described.

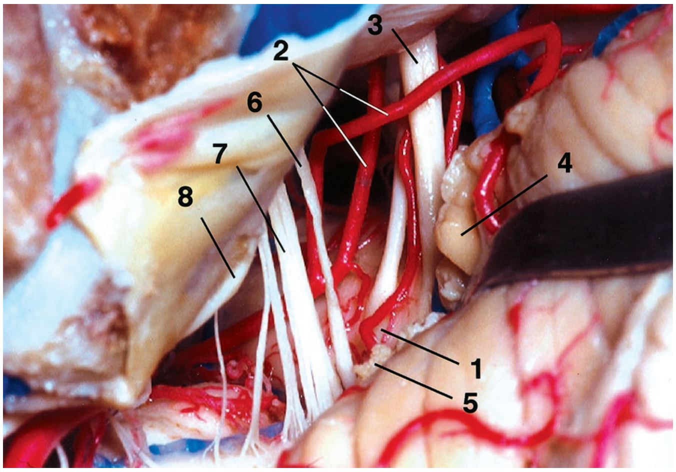

FIGURE 5. *Cadaveric specimen demonstrating an operative view of the lateral suboccipital infrafloccular approach. After retraction of the flocculus* (4) *in a caudorostral direction, the root exit zone of the facial nerve* (1) *can be observed, well separated from the vestibulocochlear nerve* (3), *between the glossopharyngeal nerve* (6) *and the flocculus. The cerebellar retraction must always be directed perpendicular to the vestibulocochlear nerve.* 2, *AICA;* 5, *choroid plexus;* 7, *vagal nerve;* 8, *accessory nerve.*

Transcondylar Fossa Approach

The park bench position and a paramedian vertical straight incision can be used for this procedure; however, the prone position and a horseshoe-shaped skin incision provide excellent observation of the entire course of the glossopharyngeal nerve, as well as a wide working space in both the extradural and intradural surgical processes (*Fig. 6A*). The skin and nuchal muscles are cut and reflected together, to expose a wide section of the unilateral suboccipital region. After detachment of the rectus capitis posterior major muscle from the inferior nuchal line, the posterior condylar emissary vein, which passes through the posterior condylar canal communicating between the vertebral venous plexus and the jugular bulb or sigmoid sinus, can be observed in the condylar fossa just behind the occipital condyle (*Fig. 1*). After the posterior condylar emissary vein is coagulated and cut, the condylar fossa can be exposed without injuring the vertebral venous plexus.

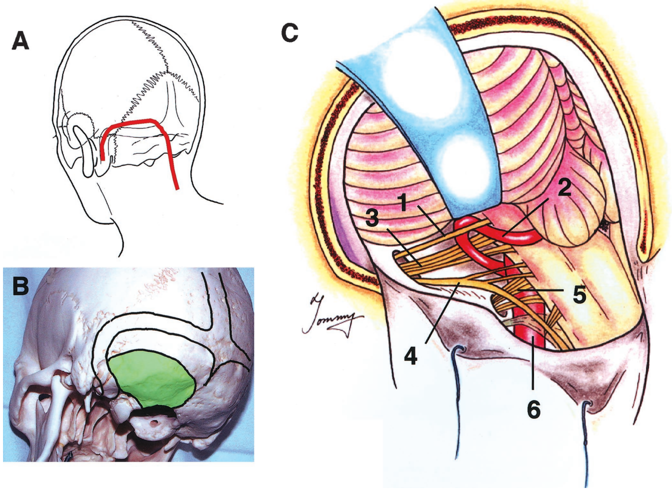

FIGURE 6. *Drawings illustrating the transcondylar fossa approach in MVD for treatment of GPN.* A, *horseshoe-shaped skin incision, in the prone position, providing wide exposure of the operative field in both the intradural and extradural processes.* B, *unilateral suboccipital craniotomy, extending from the midline medially to the sigmoid sinus, and opening of the foramen magnum. If necessary, extradural drilling of the posterior part of the jugular tubercle can be started from the condylar fossa and continued anteriorly above the posterior condylar canal.* C, *intraoperative view after slight caudorostral retraction of the inferior aspect of the suboccipital cerebellar surface, demonstrating good observation of the entire course of the glossopharyngeal nerve* (1), *the PICA* (2), *and the vertebral artery* (6). 3, *vagal nerve;* 4, *accessory nerve;* 5, *hypoglossal nerve.*

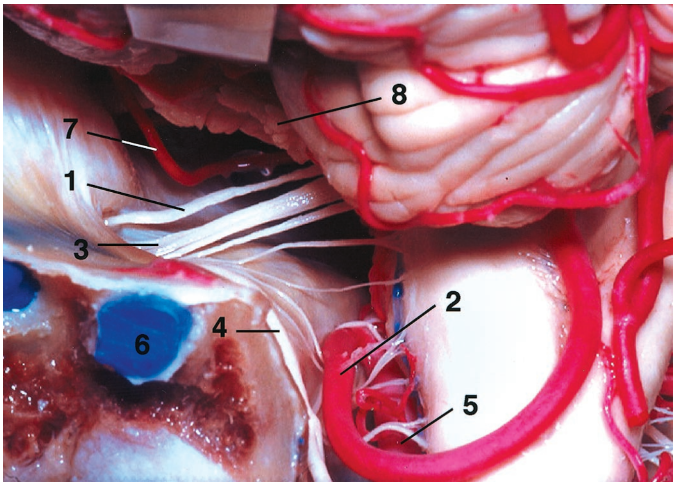

FIGURE 7. *Cadaveric specimen demonstrating an operative view of the transcondylar fossa approach. With slight caudorostral retraction of the suboccipital cerebellar surface, the entire course of the glossopharyngeal nerve* (1), *the PICA* (2), *and the vertebral artery* (5), *as well as rootlets of the vagal nerve* (3) *and the accessory nerve* (4), *can be observed. Slightly more retraction is necessary if the AICA* (7) *compresses the nerve from the rostral direction.* 6, *posterior condylar emissary vein;* 8, *choroid plexus.*

A unilateral suboccipital craniotomy is then performed, extending from the midline medially toward the sigmoid sinus laterally (*Fig. 6B*). The posterior aspect of the foramen magnum is completely opened as far laterally as the condylar fossa. Extradural drilling of the jugular tubercle starting from the condylar fossa above the posterior condylar canal offers a sufficient operative view in the inferior portion of the CPA cistern intradurally. However, excessive bone removal seems to be unnecessary in MVD for treatment of GPN. Removal of the posterior arch of the atlas, which allows increased observation caudally, is not necessary for this operation. With slight retraction of the inferior aspect of the suboccipital cerebellar surface in a caudorostral direction after opening of the dura and dissection of the arachnoid membrane of the cerebellomedullary fissure, the entire course of the glossopharyngeal nerve, the vagal nerve rootlets, the anterior and lateral medullary segments of the PICA, and the choroid plexus are clearly visible near the surgeon (*Fig. 6C*). Slightly more retraction is necessary if the AICA compresses the nerve from a rostral direction (*Fig. 7*). The compressing artery is transposed and usually fixed to the dura with the sling retraction technique. In this approach, it is not necessary to dissect the arachnoid membrane around the VIIth and VIIIth cranial nerves and the cerebellar retraction is directed vertical to, not longitudinal to, the VIIIth cranial nerve.

DISCUSSION

For MVD to treat TN, HFS, and GPN, we have modified the conventional lateral suboccipital approach, developing three different variations based on surgical anatomic features (11–14, 16, 18). According to the rule of 3, the trigeminal nerve and the SCA, the facial nerve and the AICA, and the glossopharyngeal nerve and the PICA, commonly forming nerve-artery complexes, should be accessed from the tentorial, petrosal, and suboccipital cerebellar surfaces, respectively (3, 9, 10, 19). The site of bony opening should be chosen in accordance with the approach, as outlined above.

The trigeminal nerve can be approached from the tentorial or petrosal surface; however, observation is much better from the tentorial surface, as facilitated with the infratentorial lateral supracerebellar approach, because the SCA always courses medial to the nerve and always compresses the nerve from the medial side (11). Even the caudolateral aspect of the trigeminal nerve, which is a rare site of AICA compression, can be clearly observed from the tentorial surface. Transversely directed retraction over the petrosal surface to expose the caudolateral side of the nerve might injure the VIIIth cranial nerve. Cerebellar retraction should be kept to a minimum and must not be performed transversely on the petrosal surface because the direction is parallel to the longitudinal axis of the VIIIth cranial nerve, which might cause postoperative hearing impairment.

The root exit zone of the facial nerve, which is blocked laterally by the VIIIth cranial nerve and the flocculus, must be approached from the caudal direction through a space between the glossopharyngeal nerve and the flocculus, as facilitated with the infrafloccular approach (13, 14, 16). To obtain good exposure of the root exit zone separated from the VIIIth cranial nerve, surgical access must be achieved from a strictly caudal direction. A bony opening made as far laterally as the condylar fossa and as far caudally as the foramen magnum allows much easier access, with minimal cerebellar retraction. Retraction of the flocculus must be performed in a caudorostral direction perpendicular to the VIIIth cranial nerve.

In MVD for treatment of GPN, we previously used the conventional lateral suboccipital approach. Although it was possible, it was often quite difficult to access the root entry zone of the glossopharyngeal nerve without over-retraction of the cerebellar hemisphere. Arterial compression is usually observed at the root entry zone, where the offending arteries are usually hidden behind the posterolateral sulcus of the medulla oblongata (7). We developed the transcondylar fossa or supracondylar transjugular tubercle approach, which offers excellent observation of the lateral portion of the foramen magnum, including the PICA, the vertebral artery, and the lower cranial nerves (14, 17, 18). We have applied this approach to MVD for treatment of GPN, to obtain wider closer exposure of the entire course of the glossopharyngeal nerve with slight retraction of the cerebellar hemisphere, with complete symptom cures and reductions in surgical complication rates (12). Extradural drilling of the condylar fossa and the posterior part of the jugular tubercle, which originally was the basic procedure in this lateral cranial base approach because it provides good exposure of the anterolateral aspect of the foramen magnum, is usually unnecessary for MVD.

In our series of more than 150 cases of MVD for treatment of HFS, we have never observed postoperative hearing loss of more than 15 dB or facial nerve palsy of House Grade III or worse (or any other cranial nerve palsy) (2). In our experience with more than 150 MVD procedures for treatment of TN, there were only a few cases with hearing loss (<15 dB) (20). We have not observed any postoperative cranial nerve palsy with MVD for treatment of GPN since we adopted the transcondylar fossa approach (12). The results of our series verified that our three different MVD procedures are effective for obtaining the highest rate of symptom relief with a minimal rate of surgical complications. Therefore, we think that the goal of MVD is very nearly achieved.

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Acknowledgments

We thank Professor Albert L. Rhoton, Jr., University of Florida, for teaching microsurgical anatomy. The English used in this manuscript was revised by K. Miller (Royal English Language Center, Fukuoka, Japan).

COMMENTS

The authors propose three variations of surgical approach for microvascular decompression. The concept of three variations, referred to as the "rule of 3," is potentially interesting and reasonable. However, the conventional lateral suboccipital approaches for microvascular decompression are well-established methods with minimal complication rates. We generally change the position of craniotomy and approach to the nerves according to each disease. I cannot find sufficient reason to change the approaches to the new ones proposed in this article.

At this time, the minimally invasive concept is widely adopted in neurosurgical procedures. Burr-hole surgery is even proposed for microvascular decompression. Careful retraction of the cerebellum after aspiration of cerebrospinal fluid could provide exposure of cranial nerves through a small craniotomy. In this regard, skin incision for hemifacial spasm and skin incision and craniotomy for glossopharyngeal neuralgia (GPN), as described in this article, are rather invasive. Of course, to achieve enough exposure without brain retraction may require invasive procedures. Microvascular decompression, however, is functional surgery in which patients probably prefer the minimally invasive concept to invasive procedures.

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Hitotsumatsu et al. have outlined three different approaches for microvascular decompression operations directed to the upper, middle, and lower neurovascular complexes of the posterior fossa. We use the approaches they describe in dealing with microvascular decompression of the trigeminal and facial nerves (1). All of our operations are performed as a craniotomy rather than a craniectomy. We use the lateral supracerebellar approach for trigeminal neuralgia and the infrafloccular approach for the facial nerve. We agree with the authors that direct medial retraction of the lateral cerebellar surface carries a significant risk of hearing loss. The reason is that medial retraction of the lateral surface stretches and tears the tiny filaments of the cochlear nerve as they pass through the lamina cribrosa at the fundus of the meatus. It is best to try to reach the nerves using retraction that is directed at a right angle to the eighth nerve rather than along the long axis of the eighth nerve, as previously described (1).

Our approach for the GPN is somewhat different. The hyperactive nerve syndrome of GPN affects the glossopharyngeal and upper portions of the vagus nerve. Rhizotomy involving the glossopharyngeal and upper third of the vagus nerve provides satisfactory relief and can be achieved through an infrafloccular approach with a very low risk of detectable deficits. I rarely use a far lateral approach for GPN and would be reluctant to add extradural drilling of the jugular tubercle as described by the authors. Removing the jugular tubercle extradurally in the area above the occipital condyle requires fairly extensive drilling and carries some risk of damaging the glossopharyngeal and accessory nerves as they pass above the tubercle.

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This article by the group headed by Dr. Hitotsumatsu at National Kyushu Medical Center in Japan is an excellent use of some of the anatomic contributions of other authors to the posterior fossa. They have taken these microdissections and described additional surgical approaches, which have application to a variety of pathological conditions in the posterior fossa, including tumor and vascular anomalies. Certain other pathological conditions may be applicable in a small number of microvascular decompressions but do not represent a clear improvement over the current techniques and would not merit a complete change based on that alone. We appreciate the authors' efforts to expand the operating envelope.

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This is a didactic and nicely illustrated article on the three different microvascular decompression approaches to treating the three main cranial nerve compression syndromes: 1) the infratentorial lateral supracerebellar approach for trigeminal neuralgia, 2) the lateral suboccipital infrafloccular approach for hemifacial spasm, and 3) the transcondylar fossa approach for GPN.

The authors were led to the design of the three different approaches from the anatomic side of their neurosurgical experience. They conclude that the cerebellar retraction must be directed parallel to the longitudinal axis of the eighth nerve to reduce the risk of postoperative hearing loss. Interestingly, we came to approximately the same three different approaches from the neurophysiological side of our clinical experience using intraoperative monitoring of brainstem auditory evoked potentials. Correlations of intraoperative brainstem auditory evoked potential electrophysiological changes with the surgical maneuvers led to the conclusion that auditory function was at risk when cerebellar retraction was performed from laterally to medially (which produced an increase in latency of peaks III and V) and also during vascular manipulation of the labyrinthine artery and/or its parent artery: the anteroinferior cerebellar artery in the cerebellopontine angle (which produced a decrease in amplitude of peak I) (1, 2, 5, 6).

To avoid stretching of the eighth nerve, a supracerebellar route below the tentorium with preservation of the superior petrosal sinus effluents was advocated for the approach to the trigeminal nerve. Care must be taken not to open the arachnoid posterior to the eighth nerve so that it cannot be manipulated (4).

For approaching the seventh and eighth nerve complex, an inferolateral route along the ninth to tenth nerves, then the choroid plexus emerging from the foramen of Luschka caudally to the flocculus, was advocated. This proved the more optimal and safer way to reach the facial nerve exit zone caudally, which is almost always the site of the neurovascular conflicts at the origin of hemifacial spasm (7). An even more inferolateral approach, in front of the eleventh nerve, was designed for treating the GPN, which we prefer to call *vagoglossopharyngeal neuralgia* (VGPN) because the sensory rootlets of the vagus nerve are most often involved as well when the offending loop(s) of the posteroinferior cerebellar artery and/or the vertebral artery is responsible for the pain syndrome.

Because a precise and strict codification of the surgical approaches for trigeminal neuralgia and of that for VGPN allows us to avoid hearing loss and because brainstem auditory evoked potential monitoring is far from easily available for everyday work in most institutions (intraoperative monitoring is time-consuming for clinical neurophysiologists), we gave up its use for trigeminal neuralgia and VGPN. Conversely, for hemifacial spasm, we made it a priority because of the high and constant vulnerability of the auditory function when we are working on the seventh nerve (3, 7).

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