Retrosigmoid Suprafloccular Transhorizontal Fissure Approach for Resection of Brainstem Cavernous Malformation

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Received, September 6, 2008.
Accepted, August 29, 2009.

OBJECTIVE: This study examined the usefulness of a surgical approach (retrosigmoid suprafloccular transhorizontal fissure approach) for resection of brainstem cavernous malformations (CMs).

METHODS: An anatomic study concerning the retrosigmoid suprafloccular transhorizontal fissure approach was performed with 3 cadaveric heads. Clinical course was retrospectively reviewed for 10 patients who underwent microsurgical resection of brainstem CMs with this approach. Medical, surgical, and neuroimaging records of these patients were evaluated.

RESULTS: In the anatomic study, after standard suboccipital retrosigmoid craniotomy, the horizontal fissure on the petrosal surface of the cerebellum was dissected between the superior semilunar lobule and flocculus. With this approach, the root entry zone of the trigeminal nerve and the middle cerebellar peduncle could be exposed by superior retraction of the superior semilunar lobule. The lateral surface of the pons was then easily visible around the root entry zone. When this approach was used for 10 brainstem CMs, complete resection was achieved in 9 patients (90%). No mortality was encountered in this study. New neurological deficits occurred in the early postoperative period for 4 patients but were transient in 3 patients. Neurological status at final follow-up was improved in 4 patients (40%), unchanged in 5 patients (50%), and worse in 1 patient (10%) compared with preoperative conditions.

CONCLUSION: The retrosigmoid suprafloccular transhorizontal fissure approach is useful for the resection of lateral pontine CMs.

KEY WORDS: Brainstem cavernous malformation, Horizontal fissure, Pons, Retrosigmoid approach, Surgical approach

Neurosurgery 66[ONS Suppl 2]:ons306-ons313, 2010 DOI: 10.1227/01.NEU.0000369703.67562.BB

Brainstem cavernous malformations (CMs) have been operated on since 1928.[1] However, given the relatively high perioperative morbidity/mortality rate, neurosurgeons remained reluctant to resect these lesions from the brainstem.[2] Some authors[2-10] have reported encouraging surgical results for brainstem CMs and have used several surgical approaches, depending on locations and extensions. For resection of lateral pontine CMs, subtemporal,[5,9] combined supra/infratentorial (presigmoid transtentorial),[2,4,5,7,11] translabyrinthine,[5] retrolabyrinthine,[5] suboccipital retrosigmoid,[5,7-10] and far lateral suboccipital (transcondylar)[2,4,5,9] approaches have reportedly been used. Among these, a standard suboccipital retrosigmoid approach has often been used.[5,7-10] However, stronger retraction of the cerebellum is required for direct viewing of the lateral pons through the retrosigmoid approach in contrast to the resection of cerebellopontine angle lesions. This cerebellar retraction may cause direct or vascular damage to the cerebellum and some cranial nerves.

ABBREVIATIONS: CM, cavernous malformation; **REZ**, root entry zone

We have performed dissection of the horizontal fissure of the cerebellum using a suboccipital retrosigmoid approach (retrosigmoid suprafloccular transhorizontal fissure approach), which allows ready access to the lateral pontine surface without excessive cerebellar retraction. We describe here the surgical technique and results of this approach.

MATERIALS AND METHODS

Anatomic Study

The anatomic study was performed on 6 sides of 3 cadaveric heads. Embalmed cadaveric heads were prepared and injected with a red and blue mixture containing silicone rubber (Dow Corning, Midland, MI), Thinner 200 (Dow Corning), and catalyst (Dow Corning). The retrosigmoid suprafloccular transhorizontal fissure approach was evaluated with prepared cadaveric heads. Microscopic measurements of petrosal cerebellar and lateral pontine surfaces were obtained with fine calipers.

Clinical Study

Between 1996 and 2005, a total of 35 patients with brainstem CMs underwent surgery in our hospitals. Of these, the retrosigmoid suprafloccular transhorizontal fissure approach was used in 10 patients (5 men, 5 women) who underwent resection of a brainstem CM. Mean age at the time of surgery was 36.6 years (range, 22–54 years). All patients were referred for ≥1 hemorrhage. Clinical and operative records, radiological findings, and follow-up records were reviewed retrospectively.

Selection of Operative Approach

When planning the surgical approach, we used magnetic resonance (MR) imaging to evaluate the exact location of CMs with bleeding cavities and proximity of the lesion to the pial or ependymal surface of the brainstem. The retrosigmoid suprafloccular transhorizontal fissure approach was selected for resection of CMs located in lateral lower mesencephalic to pontine lesions.

RESULTS

Anatomic Results

Surgical Procedure in Cadaveric Heads

Use of the retrosigmoid suprafloccular transhorizontal fissure approach in cadaveric heads confirmed the extent of exposure. The head was placed in the Fukushima lateral position,[12] and a C-shaped or curvilinear incision was made. After anterior elevation of the scalp and associated muscles, retrosigmoid craniotomy was performed to expose the transverse and sigmoid sinuses. After dural opening, the cerebellum was gently retracted with a spatula, allowing easy identification of the horizontal fissure[13] (petrosal fissure[14]) on the petrosal surface (Figure 1A and 1B). The fissure divides into 2 fissures rostrally and caudally at the lateral point of the flocculus (Figure 1A and 1B). Arachnoidal dissection of the fissure was started just lateral to the flocculus and continued toward the upper limb of the fissure rostral to the flocculus. Branches of the superior and anterior inferior cerebellar arteries and the vein of the great horizontal fissure[15] (the vein of the cerebellopontine fissure[16]) often run in the fissure (Figure 1C and 1D). These vessels should be preserved during dissection of the fissure. After dissection of the arachnoid membrane of the horizontal fissure, the superior semilunar lobule was easily retracted dorsorostrally with a spatula (Figure 1C and 1D). This retraction did not produce tension on the facial and vestibulocochlear nerves because these nerves connect to the pontomedullary junction medial to the flocculus. With this technique, the root entry zone (REZ) of the trigeminal nerve and the middle cerebellar peduncle were easily exposed (Figure 1C and 1D). After dissection around the REZ of the trigeminal nerve, the lateral surface of the mid to lower pons became readily visible caudal to the REZ through the horizontal fissure (Figure 1E and 1F), and the lateral surface of the upper to mid pons was also seen rostral to the REZ (Figure 1G and 1H). The caudal boundary of exposure with this approach was the lateral surface of the lower pons. Lesions caudal to the pontomedullary sulcus thus cannot be exposed with this approach. The rostral boundary of this approach was the lateral surface of the upper pons. If the lower mesencephalon needs to be exposed, the area can be seen dorsorostral to the superior petrosal vein (SPV) after dissection of the arachnoid membrane around the SPV. After intradural manipulation, the dura was closed in a watertight manner through the use of the fascial flap and fibrin glue. Cranioplasty was then performed with titanium plates. This approach using cadaveric heads allowed exposure of the lateral pontine surfaces around the REZ of the trigeminal nerve with gentle retraction of the cerebellum.

Cadaveric Measurement

In cadaveric specimens, the mean length between the horizontal fissure and the junction of the tentorial and petrosal surface of the cerebellum was 5.3 ± 2.4 mm (range, 1–8 mm) at the lateral end (Figure 2A) and 5.5 ± 2.4 mm (range, 1–8 mm) at the midpoint (Figure 2B). Mean lengths from the bifurcation of the horizontal fissure (lateral end of the flocculus) to the junction of the tentorial-petrosal and petrosal-posterior surfaces of the cerebellum (Figure 2C and 2D) were 13.6 ± 2.9 mm (range, 10–17 mm) and 23.0 ± 2.8 mm (range, 18–26 mm), respectively. The mean depth between the bifurcation of the horizontal fissure and the REZ of the trigeminal nerve was 19.0 ± 2.7 mm (range, 17–24 mm). Mean widths of the operative space rostral and caudal to the REZ were 5.3 ± 0.5 mm (range, 5–6 mm) and 8.3 ± 1.0 mm (range, 7–10 mm).

Clinical Results

Patient Population

All patients had symptoms of ≥ 1 hemorrhage (Table 1). Four patients had 1 hemorrhage, 3 patients had 2 hemorrhages, 2 patients had 3 hemorrhages, and 1 patient had 5 hemorrhages. We identified 23 hemorrhagic episodes in 409 patient-years of life. Thus, on the assumption that all lesions we resected had been present since birth, we calculated the annual hemorrhage rate as 5.6% per patient per year. Using a similar analysis, we found 11 rehemorrhages in 6 patients during 38 years of observation, for a rebleed rate of 28.9% per patient per year. The interval from first hemorrhage to time of surgery ranged from 2 months to 18 years.

Preoperative Radiographic Diagnosis

Preoperative imaging included computerized tomography, MR imaging, and cerebral angiography. All MR images revealed brainstem CMs with various phases of hematoma. Two patients displayed venous angioma located adjacent to brainstem CMs.

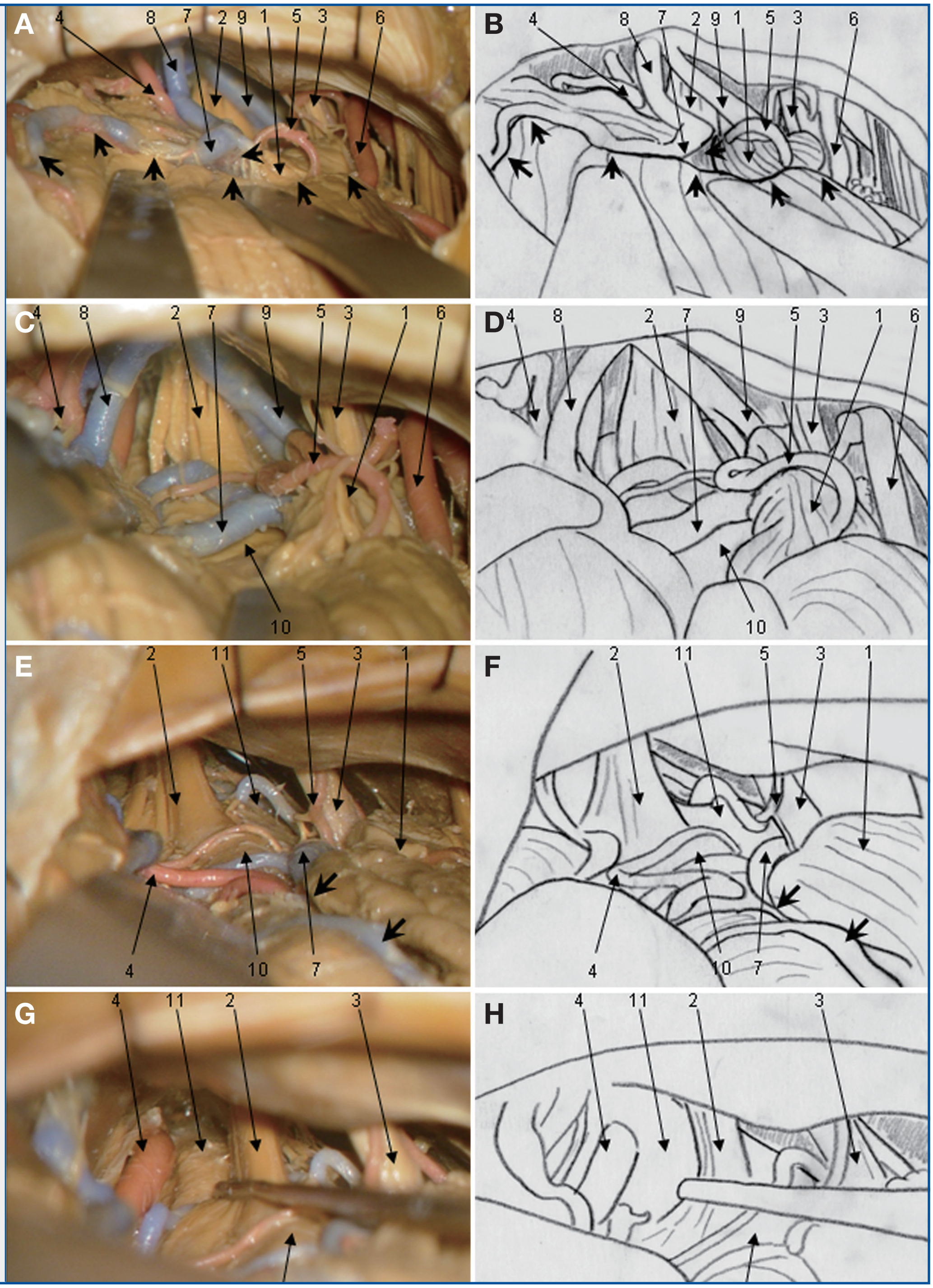

FIGURE 1. *Cadaveric specimens demonstrating an operative view of the right retrosigmoid suprafloccular transhorizontal fissure approach.* **A**, *picture and,* **B**, *illustration after dorsal retraction of the petrosal cerebellar surface of a cadaveric specimen. The horizontal fissure (arrows) is easily identified on the petrosal surface.* **C**, *picture and,* **D**, *illustration after dissection of the horizontal fissure of dorsal retraction of the petrosal cerebellar surface of a cadaveric specimen.* **B**, *The branches of the anterior inferior cerebellar artery (5), vein of the cerebellopontine fissure (7), and middle cerebellar peduncle (10) are seen in the horizontal fissure.* **E**, *picture and,* **F**, *illustration after dissection of the horizontal fissure of another cadaveric head. After rostral retraction of the superior semilunar lobule, the lateral surface of the mid to lower pons (11) is visible caudal to the trigeminal nerve through the horizontal fissure. Arrows indicate the horizontal fissure rostral to the flocculus.* **G**, *picture and,* **H**, *illustration of the same cadaveric head in* **E**. *The lateral surface of the upper pons (11) is seen rostral to the trigeminal nerve. 1 Indicates flocculus; 2, trigeminal nerve; 3, facial and vestibule-cochlear nerves; 4, superior cerebellar artery; 5, anterior inferior cerebellar artery; 6, posterior inferior cerebellar artery; 7, vein of the great horizontal fissure (vein of the cerebellopontine fissure); 8, superior petrosal vein; 9, lateral pontine vein; 10, middle cerebellar peduncle; and 11, lateral pontine surface.*

Another 2 patients had multiple CMs at supratentorial and/or infratentorial lesions. The CM location was lower mesencephalon to upper pons in 2 cases, upper to mid pons in 3 cases, mid pons in 3 cases, lower pons in 1 case, and lower pons to upper medulla in 1 case. The mean size of these CMs was 16.6 mm (range, 7–24 mm). All CMs were located superficially reaching to the pial surface of the lateral pontine or covered by thin normal brainstem parenchyma.

Surgical Treatment and Results

All operations were performed under standard microsurgical conditions with monitoring of brainstem auditory evoked

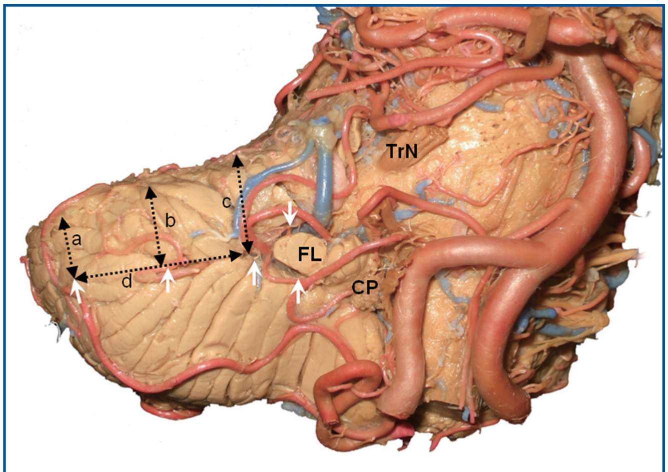

FIGURE 2. *Anterolateral view of cadaveric brain.* **A,** *length between the horizontal fissure and junction of the tentorial and petrosal surface of the cerebellum at the lateral end.* **B**, *length between the horizontal fissure and junction of the tentorial and petrosal surface of the cerebellum at the midpoint.* **C,** *length from the bifurcation of the horizontal fissure (lateral end of the flocculus) to the junction of the tentorial-petrosal surface of the cerebellum.* **D,** *length from the bifurcation of the horizontal fissure (lateral end of the flocculus) to the junction of the petrosal-posterior surface of the cerebellum. White arrows point out the horizontal fissure. CP, choroid plexus; FL, flocculus; TrN, trigeminal nerve.*

potentials and of facial nerves. The navigation system was not used in this series.

In all patients, the exposed brainstem surface displayed xanthochromic or hemorrhagic coloration at the site of CMs. After identification of the area showing colorization, incision of the brainstem was performed at this very point. The incision was as small as possible (< 10 mm in all cases) to avoid increasing neurological deficits. Location of the incision was dorsal to the superior petrosal vein in 2 cases, rostral to the REZ of the trigeminal nerve in 4 cases, and caudal to the REZ in 4 cases.

After the contents of the hematoma were sucked out, the CM was collapsed and detached from the gliotic surrounding tissue with meticulous microsurgical manipulation. The mass was then disconnected with the use of bipolar coagulation and microscissors from the tiny feeding and draining vessels. Microcurrent was very useful for removal of hematoma clot and dissection between the CM and surrounding tissue. In the 2 patients with venous malformations, these malformations were untouched after the CM was removed. After the CM had been resected and removed, the resecting margin was covered with small pieces of Surgicel (Ethicon, Somerville, NJ).

In 9 of 10 patients, the hematoma was totally evacuated, and the cavernous mass could be completely removed. Figure 3 shows images from a 23-year-old female (patient 4) with a pontine CM that was totally resected. In the patient (patient 10) with large CMs at the lower pons and upper medulla, resection was subtotal. The remaining CM was in the medial medulla. Postoperative MR images demonstrated no damage resulting from cerebellar retraction in any patient.

Postoperative Course and Outcome

In the immediate postoperative course, 6 patients (60%) displayed no new neurological deficits. The remaining 4 patients (40%) revealed additional new deficit or progression of preoperative symptoms. Of these 4 patients, 3 patients (patients 5, 9, 7 in Table 2) displayed worsened state with new trigeminal nerve palsy, new left hemiparesis, and exacerbated abducens nerve palsy, respectively. These symptoms were mild and gradually improved to preoperative states within 1 month after surgery. Another patient (patient 10 in Table 2) showed moderate facial nerve palsy preoperatively and worsened facial nerve palsy and mild cerebellar ataxia immediately after removal. Although ataxia improved within 6 months, facial nerve palsy remained at 1 year after surgery.

TABLE 1. Summary of the Preoperative Course of Patients[a]

Patient No.	Age, y/Sex	Side	Location	Size, mm	Complicated Vascular Malformations	Bleeding(s) Before Surgery, n	Interval Between First Bleeding and Operation
1	54/F	L	Lower pons	7		1	2 y
2	22/F	R	Lower mesencephalon to upper pons	20		1	2 mo
3	54/F	R	Upper to mid pons	24	Multiple CMs	2	9 mo
4	23/F	L	Mid pons	15		1	6 mo
5	48/M	R	Upper to mid pons	18		3	7 y
6	37/M	R	Lower mesencephalon to upper pons	14	Venous angioma	5	8 y
7	34/M	L	Upper to mid pons	22	Venous angioma	2	3 y
8	30/M	L	Mid pons	12		2	2 y
9	44/M	R	Mid pons	12		1	3 mo
10	31/F	L	Lower pons to upper medulla	22	Multiple CMs	3	18 y

[a] CM, cavernous malformation.

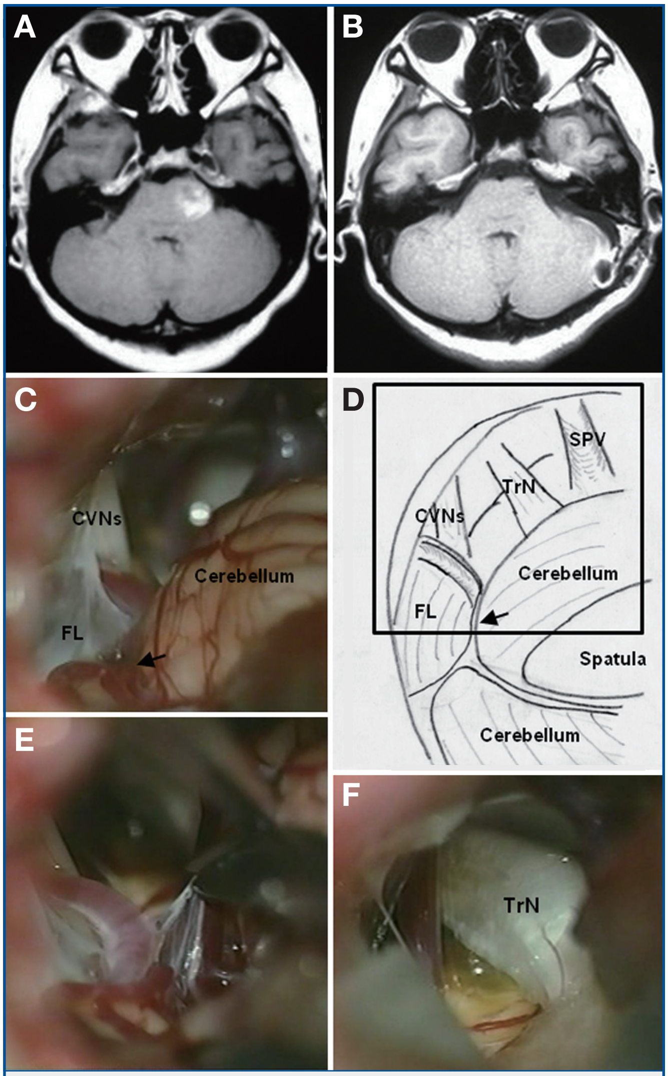

FIGURE 3. *Patient 4. A 23-year-old woman presented with headache and left facial numbness. Magnetic resonance (MR) imaging (**A**) demonstrated a cavernous malformation (CM) in the left lateral pons. In the operation, the upper limb of the horizontal fissure rostral the flocculus (black arrow) was identified (**C**). The area surrounded by a black square in the illustration (**D**) indicates the area of the intraoperative picture (**C**). After dissection of the arachnoid membrane of the horizontal fissure (**E**), the xanthochromic surface of the lateral pons was seen caudal to the trigeminal nerve (**F**). The trigeminal nerve (TrN) was caudally translocated, and incision of lateral pontine surface was performed. The CM was totally resected with meticulous microsurgical manipulation. After surgery, preoperative symptoms gradually improved. Postoperative MR image (**B**) revealed complete resection of the pontine CM. Black arrows indicate the upper limb of the horizontal fissure rostral the flocculus (FL). CVN, cochlear and vestibular nerves; SPV, superior petrosal vein.*

Comparison of neurological status at 1 year postoperatively with preoperative status showed significant improvement in 4 patients, unchanged status in 5 patients, and exacerbation in 1 patient. The clinical course of this last patient (patient 10 in Table 2) is described above.

DISCUSSION

Selection of Surgical Approaches

Various surgical approaches for resection of brainstem CMs have been reported.[2-10] These surgical approaches were chosen according to the site of CM presentation on the pial or ependymal surface.[9] For instance, a midline suboccipital approach through the floor of the fourth ventricle is usually used for resection of CMs in the midline medulla or pons presenting on the fourth ventricular surface.[9] In our 35 patients who underwent resection of the brainstem CMs, a midline suboccipital approach was used for 16 CMs under the floor of the fourth ventricle. Brown et al[17] described the so-called 2-point method to establish best access to the brainstem CM, although we did not use this method. According to them, a line between the midpoint of the CM and the point at which the lesion reaches or is closest to the brainstem surface is placed, and extension of this line indicates the best trajectory of access.

For resection of lateral pontine CMs, anterolateral approaches such as subtemporal,[5,9] combined supra/infratentorial,[2,4,5,7,11] translabyrinthine,[5] retrolabyrinthine,[5] suboccipital retrosigmoid,[5,7-10] and far lateral suboccipital[2,4,5,9] approaches have been reported. Ferroli et al[2] reported that these anterolateral pontine approaches are particularly safe and well tolerated for resection to brainstem CMs.

Of these, a standard suboccipital retrosigmoid approach has often been used.[5,7-10] Craniotomy for this approach is much easier than for other approaches. However, the cerebellum may be severely retracted for removal of brainstem CMs when a standard suboccipital retrosigmoid approach is used because the direction of this approach is lateral-posterior. If sufficient cerebrospinal fluid is allowed to egress with this approach, retraction of the cerebellum can be achieved gently. Furthermore, dissection of the horizontal fissure and retraction of the superior semilunar lobule are thought to minimize retraction of the cerebellum. We have therefore used a retrosigmoid suprafloccular transhorizontal fissure approach for resection of lateral pontine CMs. This approach was chosen in patients with pontine CMs located closer to the lateral pontine surface than the floor of the fourth ventricle. Fujimaki and Kirino[18] first reported dissection of the horizontal fissure and retraction of the superior semilunar lobule for exposing the area caudal to the REZ of the trigeminal nerve. They used both routes through the horizontal fissure and rostral to the cerebellum for microvascular decompression of trigeminal neuralgia and called this approach a combined transhorizontal/supracerebellar approach.[18] The difference between our approach and theirs is the exposure of the lateral pontine surface rostral and caudal to the REZ of the trigeminal nerve in our approach.

Anatomic Considerations for This Approach

The horizontal fissure (great horizontal fissure) is the largest fissure of the cerebellum, separating the superior semilunar and inferior semilunar lobules.[13] This fissure runs 0.5 to 1.0 cm caudal to the junction of tentorial and petrosal surfaces of the cerebellum.[18] The fissure runs medially, separating into 2 fissures at the lateral point of the flocculus. Rhoton[14] called these fissures the

TABLE 2. Summary of Intraoperative Findings and Postoperative Course[a]

Patient No.	Age, y/Sex	Rate of Removal	Location of Approach for Resection	Worsening Immediately After Surgery	Outcome
1	54/F	Total	Caudal to REZ		No changes
2	22/F	Total	Dorsal to SPV		Improved
3	54/F	Total	Rostral to REZ		Improved
4	23/F	Total	Rostral to REZ		Improved
5	48/M	Total	Rostral to REZ	Transient trigeminal nerve palsy	No changes
6	37/M	Total	Dorsal to SPV		No changes
7	34/M	Total	Caudal to REZ	Transient progression of abducens nerve palsy	Improved
8	30/M	Total	Caudal to REZ		No changes
9	44/M	Total	Rostral to REZ	Transient left hemiparesis	No changes
10	31/F	Subtotal	Caudal to REZ	Transient cerebellar ataxia, permanent progression of facial nerve palsy	Worse

[a] REZ, root entry zone of trigeminal nerve; SPV, superior petrosal vein.

petrosal fissure and superior and inferior limbs of the cerebellopontine fissure, respectively. The caudal branch of the horizontal fissure (inferior limb of the cerebellopontine fissure) extends to the choroid plexus below the foramen of Luschka. Conversely, the arachnoid membrane of the rostral branch (superior limb of the cerebellopontine fissure) wraps around the lateral side of the pons, the REZ of the trigeminal nerve, and the middle cerebellar peduncle. Dissection of the upper branch of the horizontal fissure allows dorsorostral retraction of the medial superior semilunar lobule without any tension on facial and vestibulocochlear nerves.[19,20] This procedure thus leads to easy exposure of the lateral surface of the pons around the REZ of the trigeminal nerve.[18]

The trigeminal nerve arises from the lateral surface of the lower third of the pons. The surface rostral to the REZ of the trigeminal nerve is the upper to mid pons, and that caudal to the REZ is the lower to mid pons. If the lower mesencephalon needs to be exposed, the arachnoid membrane around the SPV can be dissected and the operative space dorsal to the SPV can be used by inferior retraction of the cerebellum. If the flocculus is retracted inferiorly, the lateral surface of the pontomedullary junction is readily visible. This approach thus provides good access to the lateral lower mesencephalon and pons. However, lesions caudal to the pontomedullary sulcus are unable to be exposed with the approach outlined in this study.

Some branches of the anterior inferior cerebellar artery and SPV often run in or along the rostral branch of the horizontal fissure.[18] The rostral branch of the anterior inferior cerebellar artery courses below the facial and vestibulocochlear nerves and then above the flocculus to reach the surface of the middle cerebellar peduncle.[14,18] The branches of the SPV in the fissure include the vein of the great horizontal fissure (vein of the cerebellopontine fissure) and the lateral pontine vein (vein of the middle cerebellar peduncle). The vein of the great horizontal fissure is formed by the anterior hemispheric veins that arise on the cerebellum and passes above the flocculus on the middle cerebellar peduncle.[14] The lateral pontine vein ascends on the lateral end of the pons. These 2 veins and the transverse pontine vein join to form a SPV, which empties into the superior petrosal sinus.[14] These vessels are very important for perfusion of the cerebellum and brainstem and should be preserved as much as possible during dissection of the horizontal fissure.

Entry Zone to the Brainstem

As for the entry zone for resection of CMs, less discussion has been provided in the literature on how to incise the lateral surface of the brainstem.[3] However, in the majority of surgical cases, the exposed brainstem surface displays xanthochromic coloration at the site of the CM.[8] In all our patients, the exposed brainstem surface displayed xanthochromic or hemorrhagic coloration. In such cases, the entry zone depends on the exact site of the CM or hematoma on the brainstem surface. In the few cases in which the brainstem surface is apparently healthy with no bulging and no discoloration, anatomic or electrophysiological definition of safe entry zones to the brainstem is needed.[3] Use of navigation system may be helpful for such patients. Although we did not use a navigation system in this series, some neurosurgeons have reported the usefulness of such systems for exact localization and resection of brainstem CMs.[3,7,11]

Microsurgical Procedures

The microsurgical techniques that we used in these procedures are quite delicate and meticulous. Dissection of CMs with minimal destruction of surrounding intact brainstem is crucial. For this purpose, careful coagulation and cutting of anomalous vessels surrounding CMs are necessary. The dissection plane for resection of CMs was the embedded hemosiderin layer. The plane should be decided early during surgery and preserved for resection of CMs. Surgicel was often used after electric coagulation for hemostasis. Steinberg et al[9] also described that performing the dissection on the edge of the CMs is critically important, leaving hemosiderin-stained parenchyma intact. They reported the importance of hemostasis with small pieces of Surgicel, Gelfoam (Upjohn, Kalamazoo, MI), or cotton.[9] Another important technique is piecemeal resection of CMs after evacuation of the hematoma or clot in the CMs. This technique is necessary to avoid excessive retraction of normal parenchyma because the parenchymal opening is smaller than the lesion. Finally, preservation of any venous malformations associated with CMs is also important. Some authors[2,5,9] emphasized this preservation of associated venous malformations. Neurophysiological monitoring during surgery is useful for preserving postoperative neurological function after resection of brainstem CMs. We used brainstem auditory evoked potentials and facial nerve monitoring during surgery. Other types of neurophysiological monitoring such as somatosensory evoked potentials, motor evoked potentials, and lower cranial nerve monitoring also appear useful. Monitoring of brainstem auditory and somatosensory evoked potentials has been used more frequently.[3,9] However, few authors have mentioned the use of motor evoked potentials in brainstem CM surgery.[21]

Clinical Outcome

We performed total resection of CMs in 9 of 10 patients. However, residual CM was left in 1 patient because the CM was multilobular and visualization of the CM margin was difficult. Overall outcome at 1 year after surgery was worse compared with before surgery in 1 of 10 patients (10%), but the mortality rate was 0%. The patient with worsened symptoms displayed progression of facial nerve palsy, with no new cranial nerve palsy after resection. The results of this series are within the ranges previously reported in the literature.[2,3,5,6,8-10]

CONCLUSION

Retrosigmoid suprafloccular transhorizontal fissure approach is useful for resection of lateral pontine CMs with minimum retraction of the cerebellum.

Disclosure

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

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COMMENTS

This very interesting article expands the versatility of the retrosigmoid approach to intrinsic brainstem lesions. The opening of the horizontal fissure in fact improves brainstem visualization, reducing the need for cerebellar retraction. Despite the fact that this approach has been used successfully by many authors for approaching brainstem lesion even without opening of the horizontal fissure, this simple maneuver increases the working space and greatly reduces traction on the VII-VIII cranial nerve complex. We started to open the distal part of the horizontal fissure some years ago, after reading the article by Fujimaki and Kirino,[1] in cases of trigeminal nerve microvascular decompression in which the root entry zone visualization was difficult. We realized then that an extensive arachnoidal dissection of the superior branch of the fissure could help in visualizing the ventrolateral aspect of the upper pons without any traction on the cochlear nerve. This helped in reducing the incidence of hypoacusis after microvascular decompression. As far as the visualization of the inferolateral portion of the pons is concerned, this can be obtained by both opening the arachnoid of the inferior branch of the fissure that releases the flocculus or by delicately dividing the arachnoidal bands that keep the flocculus adherent to the VII-VIII complex and to the glossopharyngeal nerve. The combination of both techniques provides an excellent view of the region of the foramen of Luschka and the retro-olivar sulcus that can be further improved by the introduction of a 30° angled endoscope along the opened fissure. I congratulate the authors for their excellent review of the anatomy of the horizontal fissure and for their capability to transpose the anatomical experience into everyday clinical application. The AAs should be also complimented for the results that they were able to achieve with brainstem cavernomas.

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1. Fujimaki T, Kirino T. Combined transhorizontal-supracerebellar approach for microvascular decompression of trigeminal neuralgia. *Br J Neurosurg.* 2000;14(6):531-534.

This report is published to enhance neurosurgeons' awareness of a variant in facilitating surgery of lateral pontine cavernomas that can be applied after opening with a standard retrosigmoid approach, which is the simplest, fastest, and safest surgical path to the cerebellar pontine angle, in a wide sense of the term. Using cadaveric heads, the authors very clearly show that by opening the horizontal fissure of the cerebellum above the flocculus, it is possible to obtain a wide exposure of the lateral surface of the pons around the route entry zone of the trigeminal nerve and, in so doing, decrease the need to retract the cerebellum. The authors also report their surgical experience in removing 10 lateral pontine cavernomas with the technique in the title, obtaining interesting results. We do not know if this variant deserves such a flashy title (retrosigmoid suprafloccular transhorizontal fissure approach) or that it warrants being called new. One thing is certain: Although occasional in our personal experience, opening the horizontal fissure widely increases the exposure of the target area, reducing the need for cerebellar retraction. However, what must be noted is that, mainly if the patient is in the semisitting position with the head flexed and rotated toward the target site, which facilitates vision upward, a generous unroofing of the sigmoid sinus until its connection to the lateral one allows more lateral moving of the dura of the sigmoid sinus and thus increases the microscope angle toward the lateral pons and the trigeminal entry zone. Consequently, even in these cases, retraction and raising of the cerebellum can be maintained at a minimum level. Before adopting their technique, one should view what the authors seem to say with caution because the opening of the horizontal fissure is not always a simple one; it can cause damage to the cerebellum; and it is not always necessary. Moreover, the anatomy of the posterior fossa and its contents is variable; therefore, it is better to make a decision on how to reach the lateral pons surface after having explored the posterior fossa and not before.

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Ohue et al present the results of a series of 10 patients who underwent surgery for lateral pontine or lower mesencephalic cavernous malformations using a modification of the retrosigmoid approach. By dissecting the horizontal cerebellar fissure, the authors were able to spread the lobules of the cerebellum and to reduce the amount of traction placed on the cerebellum and cranial nerves to gain exposure to the lateral brainstem. The figures of the cadaver dissections illustrating the surgical anatomy are particularly valuable.

The clinical outcomes for these difficult lesions are in keeping with prior published reports.[1,2] Although this approach potentially allows less cerebellar retraction, it remains unclear whether the additional risks to the vessels within the horizontal fissure as a result of the arachnoidal dissection are worth the improvements in exposure. The morbidity incurred from resection of these cavernous malformations is more likely related to their vital location within the brainstem than to the cerebellar retraction. Our experience at Stanford since 1991 now includes microsurgical resection of 120 brainstem cavernous malformations, including 62 in the pons and 32 in the mesencephalon. We have successfully used the standard retrosigmoid or far lateral approach for the lower to mid pontine lateral cavernous malformations and the subtemporal or transpetrosal approach for the mid to upper pontine and mesencephalic lateral cavernous malformations. With cerebral spinal fluid drainage and hyperventilation, minimal cerebellar retraction is usually necessary for the standard retrosigmoid approach. Nonetheless, brainstem surgeons should be aware of this novel option to increase the size of the operative corridor for challenging lesions.

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