Tentorial detachment technique in the combined petrosal approach for petroclival meningiomas

Clinical article

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Object. The combined petrosal approach is a suitable technique for the resection of medium-to-large petroclival meningiomas (PCMs). Multiple technical modifications have been reported to increase the surgical corridor, including the method of dural and tentorial opening. The authors describe their method of dural opening and tentorial resection, and detail the microanatomy related to their technique to clarify pitfalls and effects.

Methods. The relationship of temporal bridging veins and cranial nerves (CNs) around the tentorial resection area was examined during the combined petrosal approach in 20 cadaveric specimens. The authors also reviewed their 23 consecutive clinical cases treated using this technique between 2002 and 2010, focusing on the effects and risks of the procedure.

Results. In the authors’ method, the tentorial resection extends from 5 to 10 mm anterior to the junction of the sigmoid sinus and the superior petrosal sinus (“sinodural point”) to the trigeminal fibrous ring and the dural sleeve of CN IV. Temporal bridging veins enter the transverse sinus no more than 5 mm anterior to the sinodural point. The CN IV should be freed from its tentorial dural sleeve while avoiding disruption of the posterior cavernous sinus. The clinical data demonstrate a total resection rate of 78.3%, intraoperative estimated blood loss < 400 ml at a rate of 80.9%, and a venous congestion rate of 0%.

Conclusions. Understanding the anatomical relationship between the tentorium and temporal bridging veins and CNs IV–VI allows neurosurgeons the ability to develop a combined petrosal approach to PCMs that will effectively supply a wide operative corridor after resecting the tentorium, while significantly devascularizing tumors.

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Key Words • microsurgical anatomy • petroclival meningioma • petrosal approach • skull base surgery • surgical approach • oncology

Petroclival meningiomas still present a challenging neurosurgical problem because of their propensity to engulf nerves and blood vessels, to invade the CS, and to extend to multiple cranial fossae and foramina. The combined petrosal approach is a suitable one for resection of PCMs, especially medium-to-large tumors involving the middle to upper clivus.1,4,5,15 This approach has significant advantages, such as a wide operative exposure without sacrificing hearing, early tumor devascularization, multiple axes of tumor resection, and a significant working space. Multiple technical modifications have been reported to increase the surgical corridor, and some reports have referred to the method of dural and tentorial opening.1,4,7,13,21,22 Previously published studies have excluded tentorial resection as part of the corridor for resection of PCMs. In our study, we have focused on and describe our dural opening and tentorial detachment technique in the combined petrosal approach, whereby we maximize the surgical corridor while minimizing brain injury and retraction using a cadaveric stepwise approach. Thus, we are able to visualize CNs III–XII and other related vascular structures. Furthermore, this method allows the surgeon to ligate the feeding arteries coming from the meningohypophyseal trunk and the infracavernous artery (inferior lateral trunk), compared with previous methods.1,4,7,13,21,22 We moreover confirmed the safety and utility of this approach by studying the microanatomy related to our technique in cadaveric heads and retrospectively reviewing our clinical outcomes and complication rates in 23 consecutive cases.
Microanatomy and clinical results

Methods

Cadaveric Study

Both sides of 10 cadaveric heads were dissected, for a total of 20 sides. Fresh heads harvested within 48 hours of death were used. The heads were embalmed in 70% ethanol. The common carotid arteries, vertebral arteries, and the jugular veins were dissected, cannulated, and irrigated with 70% ethanol, and then we injected colored latex solution (Ward’s Natural Science) into each vessel.

A temporal craniotomy, retrolabyrinthine temporal bone resection, and anterior petrosectomy were performed via the combined petrosal approach. The tentorial attachment to the petrous bone was resected as described below. The surgical anatomy related to the area of tentorial detachment was evaluated using the operative microscope (OME-7000, Olympus Optical Co.). The relationship between the draining veins from the temporal lobe and the junction between the SPS and SS, and the relationship of CN IV and the posterior CS were evaluated. In addition, the relationship of CN VI and trigeminal dural ring was noted.

Clinical Study

We retrospectively reviewed postoperative outcomes, noting resection rate, estimated operative blood loss, and venous congestion rate related to our tentorial resection in 23 consecutive cases of PCM treated by the senior author (T.F.) via the combined petrosal approach between November 2002 and December 2010. Postoperative CN palsies were reviewed additionally.

Results

Description of Operative Techniques

The patients are placed in a lateral position, making sure to keep the sagittal plane parallel with the floor and the cranial vertex tilted slightly down toward the floor. A lumbar subarachnoid drain was placed in all patients. A combined petrosal approach is performed as described by Fukushima and Nonaka1 and Wanibuchi et al.24 Briefly, the approach is carried out through a postauricular C-shaped scalp incision. The fascia is opened in a 2-layer fashion, providing for preparation of a vascularized fascial-pericranial flap. A mastoidectomy is performed, preserving the semicircular canals and fallopian canal. A large L-shaped temporooroccipital and suboccipital craniotomy is then made. The middle fossa dura mater is elevated from the middle fossa floor in the way that the dura propria (meningeal dura) is separated from the periosteal dura over the CN V3 and V2 divisions to expose the trigeminal dural ring through which CN V enters the posterior fossa. Peeling of the dura propria from the dorsolateral wall of the Meckel cave is stopped short of opening the SPS. The middle fossa rhomboid (Kawase triangle) is exposed, and the entire petrous apex is removed anterior to the C0 section of the ICA and cochlea and lateral to the internal auditory canal and posterior fossa dura (Fig. 1).

The dura mater of the middle and posterior fossa is opened, and preparations are made for resecting the anterior tentorium. This increases the surgical corridor and devascularizes the tumor by ligating tentorial branches of the meningo-hypophysial trunk.11,24 Small dural incisions are made along the inferior edges of the SPS at least 5 mm anterior to the SS and SPS junction (we call this the “sinodural point”);19 see Fig. 1, Arrow 1). The presigmoid dura is then opened toward the jugular bulb in an L-shaped fashion (Fig. 1, Arrow 2). An incision in the posterior fossa dura is extended from this initial dural incision to the trigeminal fibrous ring, along the SPS (Fig. 1, Arrow 3). Next, an incision is made on the posterior temporal dura along the SPS, in parallel to the first incision. It begins 5–10 mm anterior to the sinodural point. The incision along the superior edge of the SPS is also extended toward the trigeminal dural ring (Fig. 1, Arrow 4). The SPS is double-ligated and cut, staying 5–10 mm anterior to the sinodural point (Fig. 2 upper). Five to 10 mm is a safe margin from the vein of Labbé and tentorial sinus draining from the temporal base to the TS, close to the sinodural point.

The tentorium is resected in 2 steps. The posterior side of the tentorial incision is made beginning at the point of the SPS ligation and continues vertically, or slightly anteriorly, down toward the tentorial free edge (we call this procedure the “posterior tentorial detachment” technique). The incision ends behind the entrance of CN IV into the tentorium (Fig. 2 upper). The trochlear nerve is freed from its canal in the tentorium cerebelli by cutting in the superior roof of the tentorium 5–10 mm along CN IV to expose the extracavernous portion of the nerve (do not enter the posterior CS) (Fig. 2 lower). If
posterior CS bleeding is encountered, the incision should be stopped and Surgicel pieces used for hemostasis. The trigeminal fibrous ring is opened by connecting it with the incisions made along the inferior and superior edges of the SPS. The SPS is coagulated using a bipolar cautery, avoiding injury to CN V. Finally, the anterior portion of the tentorium is incised vertically from the fibrous ring of CN V to the entrance of CN IV into the posterior CS (we call this procedure the “anterior tentorial detachment” technique) (Fig. 2 lower). The PVs are cut to remove the piece of the tentorium. Arrows show the cut line of the tentorium.

Fig. 2. Photographs of specimens showing the step-by-step procedure of the tentorial resection in the combined petrosal approach for PCMs. Upper: After double ligation of the SPS, while keeping 5–10 mm away from the sinodural point, the tentorium is divided vertically toward the tentorial free edge (posterior detachment). Lower: After posterior detachment, the trochlear nerve is identified. The tentorium is cut for approximately 5–10 mm along CN IV, including opening the tentorial tunnel of CN IV. Then the incision extends along the trigeminal dural ring toward the opening of the tentorial tunnel of CN IV. The PVs are cut to remove the piece of the tentorium. Arrows show the cut line of the tentorium.

cerebellar artery and the posterior inferior cerebellar artery. Through the opening of the trigeminal dural ring, C/Ns III–V can be visualized. Cranial nerve VI courses toward the Dorello canal deep at the upper CPA (Fig. 4).

After the anterior tentorium is resected, the dura behind the clivus around CN V is coagulated with a bipolar forceps and then the PCM is further devascularized. Care should be taken to avoid injury to CN VI.

Relationships With Surrounding Structures for the Tentorial Detachment Technique

The resection points of the tentorium were defined as the area circled by the 4 points, such as point A of the SPS 10 mm anterior to the sinodural point, point B of the tentorial free edge continuing point A vertical to the midline, point C of the posterior CS beginning at the tentorial edge, and point D of the lateral trigeminal dural ring (Fig. 3). In the tentorium area defined as above, the upper side (SPS side, A–D) was 32.4 ± 3.2 mm (range 24–37 mm), the posterior side (posterior detachment, A–B) was 32.8 ± 4.5 mm (range 27–42 mm), the lower side (tentorial free edge, B–C) was 25.7 ± 3.8 mm (range 17–34 mm), and the trigeminal ring side (anterior detachment, C–D) was 10.9 ± 2.6 mm (range 7–17 mm) (Fig. 3 and Table 1). For posterior detachment, the cutting line of the tentorium should be vertical (white arrow) and should not be made going posteriorly (black arrow) because of the round shape of the tentorial incisura (Fig. 5 left).

We measured the distance between the entry point of the lateral tentorial sinus, vein of Labbé, and PVs into the tentorium from the sinodural point to determine where a posterior tentorial detachment could be made safely (Fig. 5 right). The vein of Labbé and lateral tentorial sinus are the major draining veins from the temporal base into the tentorium and are related with the posterior tentorial detachment. The vein of Labbé drained into the TS, 16.7 ± 10.4 mm (range 2–36 mm) posterior to the sinodural point; 1 vein of Labbé merged into the TS, 3 mm anterior to the sinodural point. In 15 of 20 specimens, the lateral tentorial sinus arrived into the TS 8.4 ± 6.3 mm...
(range 0–20 mm) posterior to the sinodural point; in 4 specimens (1 had no tentorial sinus) the lateral tentorial sinus emptied into the TS (50%) or SPS (50%) anterior to the sinodural point, 4.6 ± 0.9 mm (range 3–5 mm) (Fig. 5 right and Table 2). The PVs arrive into the SPS, 27.6 ± 4.9 mm (range 19–38 mm) anterior to the sinodural point (4 specimens had no PVs). The PVs are sacrificed when the tentorium is resected.

Usually the incision on the tentorium, which includes opening of a CN IV tentorial tunnel, is approximately 5–10 mm to expose the extracavernous portion of the nerve. Special care was taken in opening the tentorial tunnel of CN IV to avoid entering the posterior CS.

When devascularizing PCMs from the clivus, it is important to find the entry of CN VI into the Dorello canal. The distance between the lateral end of the trigeminal dural ring and the entry of the Dorello canal is 8 ± 2 mm (range 4–10 mm) (Fig. 4 lower, arrow). The so-called tentorial detachment technique and coagulation on the clivus completely detach feeding arteries to PCMs. The foregoing distances are expressed as the mean ± SD.

**Clinical Results in Our Group**

We reviewed the senior author’s clinical experience in the use of this technique. This is a subset of 23 of 111 consecutive patients with PCM who underwent the combined petrosal approach between November 2002 and December 2010. Operative records, neuroimaging results, and clinical histories, including postoperative follow-up, were reviewed retrospectively. In all of these patients dural incision and tentorial resection were performed using the aforementioned tentorial detachment technique. Candidates for the combined petrosal approach are healthy, < 65 years old, and present with medium-to-large tumors with substantial posterior fossa extension and dumbbell extension above the tentorium.

There were 5 male and 18 female patients ranging in age from 29 to 66 years (48 ± 10 years [mean ± SD]). Tumor size was defined as the greatest contrast-enhancing tumor diameter on MR imaging. One patient (4.3%) had a tumor < 4 cm, and 22 patients (95.7%) had tumors > 4 cm. A GTR was achieved in 11 patients, and an NTR was attained in 7 patients; the total amount of GTR and NTR was 18 (78.3%). A GTR was defined as no intraoperative evidence of residual tumor, as well as no residual tumor on postoperative imaging. An NTR was defined as the following: 1) intraoperatively observed residual tumor despite negative findings on postoperative imaging; 2) ≤ 1 cm³ of extracavernous enhancing tumor on postoperative contrast-enhanced axial plane images; and/or 3) persistent or residual intracavernous tumor of any volume. In our 23 cases, 18 patients (78.3%) had CS invasion. There were no deaths. No patient demonstrated the complications associated with venous congestion. Two patients (8.7%) suffered localized temporal lobe swelling postoperatively, probably secondary to retraction; however, they recovered completely by using perioperative steroids.

Overall, an excellent outcome, defined as a KPS score > 90 at the time of discharge or last date of long-term follow-up (> 1 year), was achieved in 18 patients (78.3%). Cranial nerve palsies were observed in several cases: 2 cases of CN V palsy; 2 of CN VI palsy; 4 of CN VII weakness (including 2 cases in which the facial nerve was rerouted and 1 in which a facial nerve was reanastomosed); and 2 of lower CN palsy (CNs IX–XII), requiring tracheotomy. In addition, intraoperative estimated blood

### TABLE 1: Distances in the tentorial resection area

<table>
<thead>
<tr>
<th>Side (point–point)</th>
<th>Distance (mm)*</th>
<th>Range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS (A–D)</td>
<td>32.4 ± 3.2</td>
<td>24–37</td>
</tr>
<tr>
<td>posterior detachment (A–B)</td>
<td>32.8 ± 4.5</td>
<td>27–42</td>
</tr>
<tr>
<td>tentorial free edge (B–C)</td>
<td>25.7 ± 3.8</td>
<td>17–34</td>
</tr>
<tr>
<td>anterior detachment (C–D)</td>
<td>10.9 ± 2.6</td>
<td>7–17</td>
</tr>
</tbody>
</table>

* Values for distance are expressed as the mean ± SD in Tables 1 and 2.
loss was calculated in 21 patients, including 17 (80.9%) with blood loss < 400 ml and 4 patients (19.1%) > 400 ml.

**Discussion**

**Devascularization and Operative Corridor**

The tentorial incision to connect the middle and posterior fossae is a standard procedure for the approach to lesions of the upper and middle clivus. Most medium and large PCMs extend into both the posterior fossa and the middle fossa, since these tend to have the classic dumbbell-shaped extension above the tentorium. These tumors obtain their vascular supply from ECA branches (such as the MMA, and ascending pharyngeal, maxillary, and occipital arteries) and/or ICA branches (such as the dorsal meningeal [lateral clival] and tentorial arteries from the meningohypophyseal trunk, and the inferolateral trunk [inferocavernous artery]) (Table 3). These arteries are interrupted by elevating the dura propria, sacrificing the MMA, and ligating the ICA branches. The anterior detachment technique, whereby the tentorium is detached from the posterior CS, results in the ligation of the feeding arteries from the tentorial artery and inferolateral trunk of ICA to the PCM. Following the tentorial detachment technique, coagulation of the clival dura by bipolar forceps further devascularizes the PCM, sacrificing the dorsal meningeal branch and the inferolateral trunk of the ICA. Finding the Dorello canal is a key element to protect CN VI from injury. De-

**TABLE 2: Distance between sinodural point and vein of Labbé/lateral tentorial sinus/PVs**

<table>
<thead>
<tr>
<th>From Sinodural Point to</th>
<th>No. of Specimens</th>
<th>Drainage to</th>
<th>Distance (mm)</th>
<th>Range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>entry of vein of Labbé (in posterior direction)</td>
<td>19</td>
<td>TS 100%</td>
<td>16.7 ± 10.4</td>
<td>2–36</td>
</tr>
<tr>
<td>entry of vein of Labbé (in anterior direction)</td>
<td>1</td>
<td>TS 100%</td>
<td>3.0</td>
<td>NA</td>
</tr>
<tr>
<td>lat tentorial sinus (in posterior direction)</td>
<td>15†</td>
<td>TS 100%</td>
<td>8.4 ± 6.3</td>
<td>0–20</td>
</tr>
<tr>
<td>lat tentorial sinus (in anterior direction)</td>
<td>4†</td>
<td>TS 50%, SPS 50%</td>
<td>4.6 ± 0.9</td>
<td>3–5</td>
</tr>
<tr>
<td>entry of PV (in anterior direction)</td>
<td>16‡</td>
<td>SPS 100%</td>
<td>27.6 ± 4.9</td>
<td>19–38</td>
</tr>
</tbody>
</table>

* The majority of entry points of the vein of Labbé/lateral tentorial sinus are posterior to the sinodural point. All entry points of the PV are anterior to the sinodural point. One vein of Labbé merged into the TS in the anterior direction, 3 mm anterior to the sinodural point. Four lateral tentorial sinuses merged into the TS or SPS in the anterior direction. Abbreviation: NA = not applicable.
† One of the 20 specimens had no tentorial sinus.
‡ Four of the 20 specimens had no PVs.
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TABLE 3: Arterial relationships in PCMs

<table>
<thead>
<tr>
<th>Relationship of feeding Arteries to PCMs</th>
<th>Steps to Sacrifice Feeding Arteries</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECA → MMA, ascending pharyngeal artery, maxillary artery, occipital artery</td>
<td>elevate dura propria → sacrifice ECA branches &amp; some of the ICA branches</td>
</tr>
<tr>
<td>ICA → meningohypophyseal trunk → dorsal meningeal artery (lat clival artery) → inferolat trunk (inferocavernous artery)</td>
<td>coagulate clival dura → sacrifice dorsal meningeal artery &amp; inferolat trunk</td>
</tr>
<tr>
<td>tentorial artery</td>
<td>→ sacrifice tentorial artery &amp; inferolat trunk</td>
</tr>
<tr>
<td>meningohypophyseal trunk</td>
<td>meningohipphalysal trunk</td>
</tr>
<tr>
<td>aneurysmal meningohypophyseal trunk</td>
<td>meningohypophyseal trunk</td>
</tr>
<tr>
<td>meningohypophyseal trunk</td>
<td>meningohypophyseal trunk</td>
</tr>
</tbody>
</table>

Vascularization of the residual capsule of a PCM also may result in limited growth of the residual tumor over time.1 In three-fourths of our cases, blood loss was < 400 ml, even though the operation lasted 8–15 hours.

The tentorium divides the middle and posterior fossa, so its detachment and partial resection are key maneuvers in the combined petrosal approach, creating a wide exposure and minimizing tension on the veins draining the temporal lobe.19 Our method of tentorial resection includes opening the trigeminal dural ring so that the Meckel cave is exposed to safely remove the tongue of tumor that often extends into the posterior CS, with visualized CN VI, as it enters the Dorello canal under the gas- 

Serian ganglion.6,8 If tumor invades to the Dorello canal, removing the posterior fossa dura over the middle fossa rhomboid area and thus opening the canal can be performed. With this method, in our clinical data, GTR and NTR were achieved in 78.3%, and a KPS score > 90 was obtained in 78.3%. These are favorable outcomes compared with previous reports, in which GTR was achieved in 37%–77%,1,3,4,22 and a KPS score > 90 was attained in 51%–77%.1,4,22

Vein of Labbé and Lateral Tentorial Sinus

Many bridging veins are encountered further posteriorly under the temporal lobe. These veins in our resection area of tentorium may include the lateral tentorial sinus, which the temporobasal veins from the basal surface of the temporal lobe are emptying into, and the veins of Labbé. Sacrifice of these veins, which pass from the lower part of the hemisphere to the TS and tentorial sinus, frequently causes some degree of venous infarction and edema of the temporal lobe.7,17,19 Compared with the vein of Labbé, the tentorial sinus is not mentioned, but should be preserved also.4,7 Sakata et al.19 reported on the anatomical study of the venous system in the petro- sal approach. According to their report, most of the veins of Labbé terminated at the TS > 10 mm posterior to the sinodural point. Our results also support the findings in this report. On the other hand, the other report mentioned that this vein generally enters the TS within 10 mm of the junction of the TS and SS.1 The vein of Labbé usually enters the TS and drains to the SPS, but it usually does so indirectly. However, Sakata et al. also reported that in only 1 (5%) of 20 specimens did the vein of Labbé empty directly into the SPS 5 mm anterior to the sinodural point. According to our study, 1 vein of Labbé in 20 specimens (5%) merged into the TS 3 mm anterior to the sinodural point.

The entry point of the temporal bridging veins anterior to the sinodural point (to SPS or TS), which corresponds to the tentorial sinus, is recognized in 25% of all entry points to tentorium.9 In 4 of our specimens, the tentorial sinus was located 3–5 mm anterior to the sinodural point. In all 20 specimens, 10% drained to the SPS and 85% to the TS directly (5% did not have this sinus). In the previous reports, the tentorial sinus entry point to SPS or TS was located > 2 cm anterior to the sinodural point in 3 (15%) of 20 specimens.9 In our measurement, the entry point was located within 5 mm anterior to the sinodural point in every specimen, including in the anterior direction. The most anterior entry point from the sinodural point was 5 mm.

We recommend that the cutting point of SPS be placed at least 5 mm anterior to the SPS, which is enough distance to protect the vein of Labbé, and the surgeon should pay attention to the entry point of the tentorial sinus to SPS or TS. The venous phase of MR angiography or venography is useful as a preoperative evaluation. In the combined petrosal approach, enough tentorial resec- tion with SPS cutting can be made without sacrificing any major bridging veins from the temporal lobe to the tento- rium. Removing the tentorium makes the operative field wide, as mentioned above, which allows one to minimize temporal lobe retraction and thus minimize postoperative complications. Even using this technique, we still had 2 cases (8.7%) in which the patients suffered from tempo- rary temporal lobe swelling caused by retraction. Less re- traction can also allow for minimum tearing or stretching of bridging veins. Also, it is noted that the veins can be reinforced with fibrin glue to avoid their rupture during temporal lobe elevations. Finally, we had no life-threatening temporal lobe swelling and also no venous infarction.

Sacrificing the SPS and PV

In our clinical series we took great care to preserve draining veins but routinely sacrificed the SPS and PV. The SPS courses within the attachment of the tentorium to the petrous ridge between the posterior end of the CS and the junction of the TS and SS. The bridging veins that join it usually arise from the cerebellum and brain- stem. Cutting the SPS along with the tentorium is stan- dard procedure for middle fossa and petrosal approaches. Other authors have noted that this does not cause venous congestion.1,4,6,7,10,12,15,21,22,26,27 In the other hand, previous reports note that sacrifice of the PVs, which drain the lat- eral part of the cerebellar hemisphere, the roof and lat- eral wall of the fourth ventricle, and the brainstem into the SPS, causes venous congestion of the cerebellum and brainstem.16,18 The risk related to sacrificing PVs appears
to be low; however, the complication in effect could be life threatening. From our experience we would recommend that the surgeon note the size of the veins. In cases in which the veins are very large, it is possible that they represent the only route of drainage and cannot be ligated. In the large PCMs, usually the PVs are already compressed by the tumor and collateral channels have developed. In exchange for sacrificing the SPS and PV, the surgeon is rewarded with an extremely wide operative field, from CN III to CN XII. Infrequently, the superficial sylvian veins may empty into the SPS, which is then called the sphenopetrosal sinus. Sectioning of the tentorium from the operative field.

Technical Considerations Related To CNs

The other key elements of our method are maximal opening of the dura along the temporal base at the edge of the SPS and opening of the tentorial tunnel of CN IV. The dural opening along the skull base is performed to provide protection for the temporal lobe as it is retracted.

The trochlear nerve is covered by the tentorium in the anterior portion of the cisternal segment, which ranged from 0.5 to 6 mm (mean 2 mm) and runs in a dural canal in the free edge of the tentorium until the level of the anterior petroclinoid fold is reached. It then runs in the lateral wall of the CS. Cutting of the tentorium is started at the posterior side because this is the location where the trochlear nerve is found easily at its cisternal portion and is uncovered by the tentorium. In the anterior tentorial detachment, cutting the tentorium covering the cisternal portion of CN IV and opening the tentorial tunnel of the nerve are performed to get the maximum view of the Meckel cave by opening the trigeminal ring appropriately and also to reduce the tension on the trochlear nerve. Youssef et al. and Cho and Al-Mefty mentioned a procedure to incise the tentorium that was similar to our method, exposing the Meckel cave; however, they didn’t mention the dural entrance of CN IV considered for maximal exposure. Our procedure creates a wider opening of the Meckel cave and safely removes remnants of the tentorium from the operative field.

Conclusions

We used cadaveric heads and clinical data to describe the methods we use for our so-called tentorial detachment technique as part of the combined petrosal approach for resection of PCMs. This technique appears to be safe to perform if one has an understanding of anatomical relationships within the tentorium, and especially the course of CNs IV–VI and bridging veins from the temporal lobe. Using this technique effectively supplies a wide operative corridor after resecting the tentorium, while significantly devascularizing tumors. This method can be one of the important steps in conducting this complex skull base operation.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Kusumi, Fukushima. Acquisition of data: Kusumi, Mehta. Analysis and interpretation of data: Kusumi. Drafting the article: Kusumi, Nonaka. Critically revising the article: Fukushima, Mehta, Aliabadi, Friedman. Reviewed submitted version of manuscript: Fukushima, Mehta, Aliabadi, Nonaka, Friedman, Fujii. Approved the final version of the manuscript on behalf of all authors: Kusumi. Administrative/technical/material support: Fukushima, Nonaka. Study supervision: Fukushima, Fujii.

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