Significance of the tentorial alignment in approaching the trigeminal nerve and the ventral petrous region through the suboccipital retrosigmoid technique

Burak Sade, M.D., and Joung H. Lee, M.D.

Object. In this study, the authors aimed to identify the factors that would predict the operative distance between the trigeminal nerve (fifth cranial nerve) and the acousticofacial nerve complex (seventh–eighth cranial nerves) preoperatively when approaching the cerebellopontine angle (CPA) through the suboccipital retrosigmoid approach.

Methods. In 40 consecutive patients who underwent microvascular decompression of the trigeminal nerve via a suboccipital retrosigmoid approach for trigeminal neuralgia, the following three parameters were assessed on preoperative magnetic resonance images: 1) the angle between the tentorium and the line drawn from the hard palate (tentorial angle); 2) the angle between the lines drawn along the petrous bones ventral to the internal auditory canals (petrous angle); and 3) the angle between the tentorium and the line connecting the opisthion to the inion (occipital angle). The distance between the trigeminal nerve and the acousticofacial nerve complex (referred to as “distance”) was measured intraoperatively. Statistical analysis was performed using the Pearson correlation test.

Results. The mean values were 50.9 ± 11.5° for the tentorial angle, 102.5 ± 13.1° for the petrous angle, 83.4 ± 9.7° for the occipital angle, and 3.1 ± 1.5 mm for distance. There was a strong inverse correlation between the tentorial angle and distance ($r = -0.228, p = 0.08$). The mean distance was 3.5 ± 1.9 mm for a tentorial angle less than 51° and 2.7 ± 1.1 mm for a tentorial angle of at least 51°. No correlation existed between either the petrous or occipital angles and distance.

Conclusions. The distance between the trigeminal nerve and acousticofacial nerve complex decreases in the presence of a steep tentorial angle. This limits the operating field between these cranial nerves when reaching the petroclival or the superior CPA regions through the retrosigmoid approach. Awareness of such anatomical features at the time of preoperative planning is of paramount importance in selecting the optimum surgical approach and minimizing operative complications. (DOI: 10.3171/INS-07/11/0932)

Key Words • cerebellopontine angle • petroclival region • retrosigmoid approach • tentorium • trigeminal nerve

The suboccipital retrosigmoid approach is a well-established route for MVD procedures, sectioning of the vestibular nerve for intractable Ménière disease, and resection of CPA tumors. It is also a valid alternative in the treatment of selected patients with tumors of the petrotentorial sulcus such as trigeminal schwannomas as well as ventral petrous and petroclival meningiomas. However, certain anatomical factors may complicate the surgery during this approach, such as the prominence of the petrous tubercle, depth of the posterior fossa (petrous angle), size of the cerebrospinal fluid spaces, venous anatomy, and the displacement of the neurovascular structures in the presence of tumoral lesions. In this context, we believe that among the most significant factors in determining the complexity of reaching the superior CPA or petroclival region is the operative distance between the trigeminal nerve (fifth cranial nerve) and the acousticofacial nerve complex (seventh–eighth cranial nerves).

In this study, we aimed to assess certain morphometric features of the posterior fossa that would help predict the distance between the trigeminal nerve and the acousticofacial nerve complex at the time of preoperative planning. For this purpose, we looked at the role of the tentorial, petrous, and occipital angles and developed the following three hypotheses: Hypothesis I, the steeper the tentorial angle, the shorter the distance between trigeminal nerve and the acousticofacial nerve complex; Hypothesis II, the wider the petrous angle, the shorter the distance between the trigeminal nerve and acousticofacial nerve complex; and Hypothesis III, the narrower the occipital angle, the shorter the distance between the trigeminal nerve and acousticofacial nerve complex.
Clinical Material and Methods

Between January 2004 and December 2005, 40 consecutive patients with trigeminal neuralgia who underwent MVD were evaluated prospectively. There were 13 men and 27 women, with an average age of 61 years (range 31–86 years).

The following parameters were measured for each patient in the preoperative period: tentorial angle, the angle between the tentorium and the line drawn from the hard palate on midsagittal MR imaging (Fig. 1A); petrous angle, the angle between the lines drawn along the axis of the petrous bones ventral to the internal auditory canals on axial MR imaging (Fig. 1B); and occipital angle, the angle between the tentorium and the line connecting the opisthion to the inion on midsagittal MR imaging (Fig. 1C).

All patients underwent surgery through a simplified suboccipital retrosigmoid approach, and the distance between the trigeminal nerve and acousticofacial nerve complex in the CPA was measured intraoperatively at the time of the initial exposure (referred to as “distance”). For this purpose, premeasured tapered retractor tips were used as measuring instruments.

Correlation analyses of the three preoperative parameters and the intraoperative distance of the trigeminal nerve to acousticofacial nerve complex were performed using the one-tailed Pearson test.

Results

The mean values (± standard deviations) were 50.9 ± 11.5° for the tentorial angle, 102.5 ± 13.1° for the petrous angle, and 83.4 ± 9.7° for the occipital angle. The mean distance between the trigeminal nerve and acousticofacial nerve complex was 3.1 ± 1.5 mm (Table 1).

There was a strong inverse correlation between the tentorial angle and distance (r = −0.228, p = 0.08) suggesting that the steeper the tentorial angle, the narrower the distance between the trigeminal nerve and acousticofacial nerve complex was (Fig. 2A). The mean distance was 2.7 ± 1.1 mm for a tentorial angle of at least 51° compared with 3.5 ± 1.9 mm for a tentorial angle less than 51°.

There was no correlation between the petrous angle and distance (Fig. 2B) or occipital angle and distance (Fig. 2C).

Discussion

Measurement Methods

In the literature, quantitative analyses of the tentorial alignment and other morphometric parameters of the posterior fossa have been studied mainly in reports in reference to Chiari malformation. However, there is no agreement over the methods of the various measurements. The angle between the tentorium and the line drawn from the tuberculum sellae to the inion (Twining line) or the angle between the tentorium and the line drawn from the opisthion to the inion (occipital angle in the present study) have been used in some papers. In our study, we used the angle between the tentorium and the line drawn along the hard palate. In our experience, this gave us an easy and practical assessment of the tentorial angle even with the naked eye, given that the hard palate has an almost horizontal alignment in most instances when the head is in the neutral position.

The lack of a standardized measurement method applies to the petrous angle as well. Jeffery described this angle as that between the lines drawn from the medial petrous ridge to the lateral petrous ridge on each side. Others have defined it as the angle between the two lines drawn from the median point of the posterior surface of the clivus to the posteromedial surface of the petrous bones bilaterally at the level of the internal auditory meatus. Smith and Mumford measured the angle at the site where it is crossed by the trigeminal nerve by using a plaster model of the bone.

We conducted our study in patients undergoing MVD for idiopathic trigeminal neuralgia because their CPA anatomy is not distorted by the presence of tumors. We hypothesized that a steeper tentorial angle would cause crowding of the posterior fossa, especially at the CPA and the petrotentorial sulcus and therefore would narrow the distance between the trigeminal nerve and the acousticofacial nerve complex. This was confirmed by our findings. It was also our assumption that a narrow occipital angle would have a similar impact on the relationship of these nerves by causing more crowding in the posterior fossa as was hypothesized for the tentorial angle. As for the petrous angle, in our experience, we have found a wider petrous angle to be a challenge in accessing the superior CPA or ventral petrous region through the suboccipital retrosigmoid approach. We hypothesized that the widened petrous angle would...
might represent nature’s way of compensating for the anatomical crowding (that is, the narrowing distance between the cranial nerves) at the CPA. However, both of these parameters (occipital angle and petrous angle) failed to show any correlation with the distance between the nerves.

Practical Implications

Various technical nuances have been described in approaching the tentorial angle and superior CPA during MVD. In their analysis of 4400 MVDs (3196 for trigeminal neuralgia), McLaughlin and colleagues\(^\text{10}\) recommended not to start the dissection from the acousticofacial nerve complex when one intends to reach trigeminal nerve, because of the concern for the retraction injury to the cochlear nerve. Others have also advocated to approach the trigeminal nerve through the tentorial cerebellar surface (that is, the infratentorial lateral supracerebellar approach\(^\text{9}\)) rather than the petrosal surface because of the same concern.\(^\text{5}\) In practice, we believe that the operative distance between the trigeminal nerve and acousticofacial nerve complex is among the key elements in the intraoperative injury of the cochlear nerve, especially when the surgeon is less experienced and is not prepared for the possibility of a narrow distance.

The operative distance between trigeminal nerve and acousticofacial nerve complex is among the most important factors when approaching the ventral petrous or petroclival meningiomas through the retrosigmoid route because the surgeon must work through the space between trigeminal nerve and acousticofacial nerve complex to reach the lesion. Although more complex skull base techniques have been advocated in the management of these lesions,\(^\text{3,13}\) the simple retrosigmoid approach has been used in as much as 70% of patients with petroclival meningiomas in some reported series,\(^\text{1,2,4,15}\) which is also our preferred approach for most of the superior CPA and petroclival pathological entities. The retrosigmoid approach is considered the simplest route to the CPA and lateral clivus; however, the working field consists of small spaces in between the tentorium and trigeminal nerve, between the trigeminal nerve and acousticofacial nerve complex, and between acousticofacial nerve complex and the lower cranial nerves.\(^\text{1}\) In the presence of larger tumors, the operative accessibility to the tumor is facilitated by the corridor created by the tumor. However, bleeding from the superior petrosal sinus or cavernous sinus may be more difficult to control.\(^\text{4}\) The same controversy exists regarding the feasibility of the retrosigmoid approach in the management of trigeminal schwannomas. Although it has been suggested that this approach may not be sufficient for adequate tumor resection,\(^\text{19}\) Samii and colleagues\(^\text{14}\) have demonstrated its applicability, especially in tumors with a predominant posterior fossa component. The extent of exposure provided by the various operative spaces between the tentorium, trigeminal nerve, acousticofacial nerve complex, and the lower cranial nerves are again of significance in determining the complexity of the procedure.

In rare instances, however, the exposure of the trigeminal nerve may be hindered by a prominent petrous tubercule. In three of the patients in this series, we had to drill the tubercule to visualize and to dissect around the trigeminal nerve to adequately perform MVD. The modification of the standard retrosigmoid approach, with the addition of this suprameatal drilling has been described as an efficient route to reach the more distal trigeminal nerve and Meckel cave.\(^\text{16,17}\)

Currently, we assess the tentorial angle in every patient with trigeminal neuralgia in whom MVD is planned or in patients with superior CPA, ventral petrous, or petroclival tumors in whom a retrosigmoid approach is considered. Patients present with a wide range of tentorial angles (Fig. 3) and knowing that an extremely narrow distance between the trigeminal nerve and acousticofacial nerve complex (Fig. 4) may be encountered in patients with a steep tentorial angle, a relatively less experienced surgeon may consider another treatment modality rather than MVD in a pa-

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**TABLE 1**

*Descriptive analysis of the parameters*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>tentorial angle (°)</td>
<td>25</td>
<td>85</td>
<td>50.9 ± 11.5</td>
</tr>
<tr>
<td>petrous angle (°)</td>
<td>69</td>
<td>125</td>
<td>102.5 ± 13.1</td>
</tr>
<tr>
<td>occipital angle (°)</td>
<td>59</td>
<td>102</td>
<td>83.4 ± 9.7</td>
</tr>
<tr>
<td>trigem nerve–AFC distance (mm)</td>
<td>0</td>
<td>8</td>
<td>3.1 ± 1.5</td>
</tr>
</tbody>
</table>

* AFC = acousticofacial nerve complex; SD = standard deviation; trigem = trigeminal.

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**FIG. 2.** Graphs showing the correlation between the trigeminal nerve to acousticofacial nerve complex distance and the tentorial angle \(r = -0.228, p = 0.08\) [A], petrous angle \(r = 0.119, p = 0.23\) [B], and occipital angle \(r = -0.102, p = 0.27\) [C].
Tentorial alignment in the suboccipital retrosigmoid approach

Fig. 3. Magnetic resonance images showing the tentorial angle measurements in two patients.

Fig. 4. Intraoperative photograph showing a narrow distance between the trigeminal nerve and the acousticofacial nerve complex in a patient with a steep tentorial angle (right side shown). Fl = flocculus; PT = petrous tubercule; Ret = retractor; T = tentorium; V = trigeminal nerve; VII/VIII = acousticofacial nerve complex.

patient with trigeminal neuralgia, or alternative surgical approaches to the petroclival region tumors to assure patient safety and operative success.

Conclusions

The distance between the trigeminal nerve and the acousticofacial nerve complex decreases in the presence of a steep tentorial angle. This limits the operative space between these cranial nerves during MVD or removal of tumors from the superior CPA or petroclival regions. Awareness of such anatomical features at the time of preoperative planning is of paramount importance in selection of optimum surgical approach and minimizing operative complications.

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References


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Address correspondence to: Joung H. Lee, M.D., Brain Tumor Institute/Department of Neurosurgery, Cleveland Clinic, 9500 Euclid Avenue, R20, Cleveland, Ohio 44195. email: leej@ccf.org.