Microsurgical and Endoscopic Approaches to the Basilar Bifurcation: Quantitative Comparison of Combined Pterional/Anterior Temporal and Orbitozygomatic Extended Approaches

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ABSTRACT

To determine the most effective route to the upper third of the basilar artery, 10 cadaver dissections were performed comparing the exposure gained using the combined pterional/anterior temporal approach and the orbitozygomatic extended approach. Endoscopic evaluation through an eyebrow incision in each dissection helped determine whether any advantage was conferred by the cranial base approach. This also served to assess the benefit of using the endoscope as an adjunct to open procedures in evaluating the opticocarotid and retrocarotid routes to the basilar artery. The results of cadaveric dissections suggest that compared with the exposure afforded by the combined pterional/anterior temporal approach, the orbitozygomatic extended approach yields an increase of 8 cm in the anteroposterior axis and 10 cm in the superoinferior axis. Furthermore, as expected, the increases in visibility were directed anteriorly and posteriorly. When employed through the craniotomy site during aneurysm clipping, endoscopy was found to be potentially useful in assessing the contralateral elements of the upper basilar complex.

KEYWORDS: Basilar artery, aneurysm, orbitozygomatic, endoscope, pterion

The clipping of aneurysms in the upper basilar complex has traditionally been technically challenging because of the depth of the workspace and the critical structures that obstruct visualization of this area. Drake¹ popularized the subtemporal approach, and Yasargil² later published the first description of the pterional transsylvian approach as an effective route to these lesions. More recently, modifications have been made to both of these now standard approaches to shorten the depth of the surgical field and increase the arc of visibility. The combined pterional/anterior temporal approach has evolved as a hybrid of the two traditional routes of exposure. It combines the anterior angle of visualization of the pterional and the lateral perspective of the subtemporal approach without elevation of the temporal lobe. With the advent of skull base techniques, the orbitozygomatic approach has emerged as useful in managing lesions of the upper basilar complex. To evaluate the combined pterional/anterior temporal and the orbitozygomatic approaches with respect to disparities in exposure, a cadaver study was undertaken, using both microscopic and endoscopic visualization. Endoscopy was further evaluated with regard to its usefulness in open procedures.

MATERIALS AND METHODS

In this anatomic series, five formalin-fixed cadaver heads were prepared by six-vessel latex injection. Each specimen was placed in Mayfield 3-point fixation and positioned so that the head was rotated 45 degrees to the opposite side. The combined pterional/anterior temporal approach was then used to expose the upper basilar complex with particular emphasis on aggressive bony removal at the posteroinferior aspect of the craniotomy. Maximal retraction and anterior temporal lobe resection were carried out to minimize this variable. Only minimal retraction of the frontal lobe was necessary. The posterior clinoid was chosen as a reference

point from which to measure the angle of visibility in the anteroposterior and superoinferior planes because of the variable height of the upper basilar complex. This angle was measured by calculating the distance between two pieces of suture tacked to the ipsilateral posterior clinoid process when the bony and soft tissue margins were abutted in the anteroposterior and superoinferior frames of reference. Next, an orbitozygomatic osteotomy was performed on the same craniotomy site, and the two angles were once again measured with the new margins.

Because early attempts to evaluate the two approaches endoscopically through a supraorbital burr hole were disappointing, the endoscopic probes were passed ipsilaterally through the craniotomy to investigate the contralateral aspect of the upper basilar complex (the contralateral P1 segment and the perforators). A 70-cm rigid endoscope was employed in all cases.

RESULTS

The addition of orbitozygomatic osteotomy to a regular pterional/anterior temporal craniotomy yielded an additional 8 cm in the anteroposterior extent and 10 cm in the craniocaudal axis. When endoscopic measurement was employed, this difference in the dimensions between pterional craniotomy and craniotomy combined with orbitozygomatic extension was significant. Extended craniotomy with orbitozygomatic osteotomy had a mean ($\pm$ standard deviation) angle of visibility of 56 ± 5 degrees in the anteroposterior direction (Fig. 1) compared with 48 ± 6 degrees using a combined pterional/anterior temporal craniotomy ($P < 0.01$). Similarly, in the craniocaudal axis, the orbitozygomatic extension produced a mean angle of visibility of 61 ± 9 degrees (Fig. 2) compared with 51 ± 9 degrees using the combined pterional/anterior temporal approach ($P < 0.05$) (Table 1).

Figure 1 Approximate cones of visibility for the anteroposterior axis with and without orbitozygomatic craniotomy.

Endoscopic evaluation was found to be an effective and minimally invasive way to image both the ipsilateral and contralateral aspects of the upper basilar complex (Figs. 3, 4).

CASE STUDY

A 37-year-old woman presented with intractable headaches of 1-month duration. She reported two episodes of syncope 1 week before presentation.

Figure 2 Approximate cones of visibility for the superior/inferior axis with and without orbitozygomatic extension of craniotomy.

Table 1 Mean Angles of Visibility

Approach	Anterior/ Posterior	Craniocaudal
Orbitozygomatic	56 ± 5 degrees	61 ± 9 degrees
Pterional/anterior temporal	48 ± 6 degrees	51 ± 9 degrees
P value	< 0.01	< 0.05

Her memory was slightly impaired, and she had mild gait difficulties and decreased dexterity. On angiography, she was found to have a basilar bifurcation aneurysm measuring approximately 10 mm that was pointing superiorly with a good neck (Fig. 5). A pterional craniotomy with orbitozygomatic extension was performed to expose the dura, which was flush with the cranial base. Both PCAs were identified and the neck of the aneurysm was clipped through the opticocarotid space. Intraoperative angiography, a routine procedure for all posterior circulation aneurysms, was helpful in confirming the proper placement of the clip (Fig. 6).

DISCUSSION

The basilar bifurcation lies above the posterior clinoid process in 50% of cases, at the level of clinoid in 30%, and below the bony landmark in 20%.³

Figure 3 Endoscopy showing the basilar artery perforators.

Figure 4 Contralateral P1 segment visualized with endoscope.

Drake⁴ introduced the classic subtemporal approach to basilar bifurcation aneurysms. A standard pterional craniotomy detailed by Yasargil² introduced the anterior trajectory to the operative approaches to basilar bifurcation. After describing the subtemporal approach to basilar artery aneurysms, Drake appropriately added a half-and-half version to reach aneurysms of the basilar tip above the dorsum sellae. These modifications generally provide excellent accessibility to the basilar tip along the lateralized trajectories. Sano⁵ and Dolenc et al.⁶ introduced a temporopolar approach by mobilizing the temporal pole posteriorly, thus adding

the anterior and lateral trajectories to the conventional pterional approach. These methods were improved with the addition of orbitozygomatic extension.⁷⁻⁹ The advantages of this extension in clinical experience were recently described.¹⁰

The orbitocranial base approaches that encourage a shallower and wider depth of field are beneficial particularly when improvement in anterior and caudal visualization is necessary to ensure adequate access to the upper basilar region. The results of our small cadaver study suggest that orbitozygomatic osteotomy adds approximately 8 cm in the anteroposterior axis and 10 cm in the superoinferior (craniocaudal) axis to the visibility provided by the combined pterional/anterior temporal approach. As upward frontal lobe and posterolateral temporal lobe retraction were held constant, the increase in anterior and inferior visualization effectively flattened out the line of vision to the floor of the middle temporal fossa and anteriorly to the lateral aspect of the orbital contents. Although orbitozygomatic osteotomy is more invasive and time consuming and the exposure afforded by the combined pterional/anterior temporal approach is often adequate, the added degree of visualization at the anterior and inferior margins of the exposure can be useful. This is particularly true for high basilar bifurcation aneurysms and giant aneurysms.

Figure 5 Angiogram demonstrating basilar bifurcation aneurysm.

Figure 6 Intraoperative angiogram demonstrating the patent PCA after clip placement on the aneurysm.

CONCLUSIONS

For aneurysms at the level of the posterior clinoid process or giant aneurysms, visualization of contralateral vessels is important. The transclavous strategy introduced by Dolenc et al.⁶ and Fujimoto et al.¹¹ would improve the visibility of these aneurysms by removal of the bony process and mobilization of the carotid artery and of the optic and oculomotor nerves. Since endoscopy provides adequate visualization of the top of the basilar artery without the extra surgical exercise, it might be a promising alternative to the transclavous strategy. We do not consider a separate approach or burr hole necessary but recommend that it be used through the same craniotomy to aid in inspection of the basilar perforators and the contralateral P1 segment. This can be done with minimal morbidity and mortality, imparting an added measure of safety and efficacy in enabling the assessment of clip placement and the patency of surrounding vessels. However, the intraoperative value of endoscopic visualization is evolving, and its indications for basilar artery aneurysms remain to be established.

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