Cortical osteotomy technique for mobilizing the temporal muscle in pterional craniotomies

Technical note

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Although many procedures have already been performed to mobilize and reconstruct the temporal muscle for pterional craniotomies, the authors described a novel cortical osteotomy technique for creating and mobilizing a cortical bone slat along the superior temporal line with the temporal muscle attached to it. Screw fixation of the cortical bone slat then provides secured temporal muscle reconstruction. As such, this new technique minimized damage to the temporal muscle and prevented the formation of an anterior temporal hollow. In addition, key hole and parietal burr hole defects were covered by the cortical bone slat.

KEY WORDS • anterior temporal hollow • cortical osteotomy • surgical technique • pterional approach • reconstruction • temporalis muscle

MOBILIZING the temporal muscle is essential for making a free bone flap in pterional and cranioorbital approaches, and a number of different methods have already been used for such mobilization and reconstruction of the muscle.1–9,11–13,15 In this paper we present a novel technique for mobilizing and reconstructing the temporal muscle in which we perform a cortical osteotomy along the superior temporal line. In addition, its technical feasibility was assessed prospectively, and its effect on postoperative anterior temporal hollows—the most remarkable cosmetic sequela of temporal muscle atrophy—was also evaluated.

Clinical Material and Methods

Patient Population and Data Collection

In 2003 we performed pterional craniotomies in 152 cases of aneurysm surgery. A cortical osteotomy technique was performed in 35 cases, whereas a conventional pterional craniotomy involving a muscular cuff along the superior temporal line was performed in the other 117 cases. A prospective analysis of the 35 consecutive patients who had undergone the cortical osteotomy technique was conducted, and data from the prospective patient cohort were analyzed with respect to the procedure’s technical feasibility, complications, and required operative time.

Anterior temporal hollows in patients who had undergone the cortical osteotomy were compared with those in a group of control patients who had undergone a conven-

TABLE 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tr>
<td></td>
<td>Cortical</td>
</tr>
<tr>
<td>no. of patients</td>
<td>24</td>
</tr>
<tr>
<td>age (yrs)*</td>
<td>50.5 ± 11.3</td>
</tr>
<tr>
<td>sex (F/M)</td>
<td>13/11</td>
</tr>
<tr>
<td>thickness of temporalis muscle (mm)*†</td>
<td>6.1 ± 1.9</td>
</tr>
</tbody>
</table>

* Values represented as the means ± standard deviations.
† Thickness of temporalis muscle in the anterior temporal area 2 cm above the frontal base as measured on a CT scan.

In addition, peridental peridental craniotomy and were evaluated on the basis of CT scans obtained preoperatively and more than 3 months postoperatively. Twenty-four patients from the cortical osteotomy group and 48 in the conventional craniotomy group were included in this study. The two study groups were well matched for such variables as patient age and preoperative temporal muscle thickness in the anterior temporal area (Table 1).

Computerized Tomography Evaluation

The thickness of the temporal muscle was measured in the anterior temporal area approximately 2 cm above the frontal base on CT scans. An anterior temporal hollow caused by temporal muscle atrophy was classified according to the percentage decrease in the thickness of the temporal muscle more than 3 months after surgery relative to its preoperative thickness: Grade 0, unremarkable hollow, de-
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The scalp incision is the same used in the standard pterional approach. The frontotemporal branch of the facial nerve is preserved using the standard interfascial dissection method. A zygomatic process of the frontal bone is exposed. The temporalis fascia is opened sharply with scissors, and the temporal muscle incised using a cautery in line with the scalp incision.

The pericranium is incised above the superior temporal line and reflected away to expose a drilling area. To make a cortical bone slat with the temporal muscle attached to it, a Midas Rex drill with a C1 attachment is applied along the superior temporal line. The drill bit is angled to make a cut through the cancellous bone between the inner and outer tables. Thin osteotome cuts through the cancellous bone finish the osteotomy to make a cortical bone slat measuring approximately 6 × 1.5 cm. The oblique application of the drill bit and thin osteotome are intended to prevent any violation of the inner table of the skull and underlying dura mater (Fig. 1). The temporalis muscle is sharply dissected from the temporal fossa by using a retrograde dissection technique, as described by Oikawa, et al., whereas the muscle attached to the cortical bone slat is preserved.

Thereafter, a free bone flap is made using three burr holes in the usual fashion. Two of the three burr holes—a key hole and a parietal burr hole—are positioned within the confines of the decorticated bone along the superior temporal line (Fig. 2). The third burr hole is located in the squamous temporal bone above and anterior to the root of the zygoma. The three burr holes are connected using a craniotome, and the sphenoid wing is drilled out as usual.

The bone flap is secured following the usual intracranial procedure. The cortical bone slat together with the attached temporal muscle is then fixed to the secured bone flap by using two or three 7-mm-long screws. Initially, the screw sites are prepared by slight monopolar cautery of the temporal muscle on the bone slat. Then, the screws are obliquely directed into the bone at the superior temporal line. The temporal muscle and fascia are closed in separate layers (Fig. 3).

Statistical Analysis

Data in this report are presented as the means ± standard deviations. A chi-square analysis was used to compare the cortical osteotomy group and the conventional craniotomy group in terms of the development of a postoperative anterior temporal hollow. Significance was set at a probability value less than 0.05.

Results

Technical Feasibility of the Cortical Osteotomy

The proposed technique was used in 35 adult patients (19 men and 16 women) to place clips on intracranial aneurysms. The bone along the superior temporal line, which was measured at the parietal burr hole, was 6.1 ± 0.9 mm thick and thus thick enough to slice using the cortical osteotomy technique. The dura mater was exposed in eight cases (23%) while making the cortical bone slat; in only two of these cases did the patient suffer a dural laceration without
brain injury. The operating time required for this procedure was 12.1 ± 1.8 minutes, that is, 6.6 ± 1.3 minutes for the cortical osteotomy and 5.5 ± 1.0 minutes for the bone slat fixation with two or three screws.

Comparison Between Cortical Osteotomy and Conventional Craniotomy Groups

Only two patients (8.3%) in the cortical osteotomy group demonstrated an anterior temporal hollow, whereas 42 patients (87.5%) in the conventional craniotomy group revealed a mild-to-severe hollow (Table 2). As such, a statistically significant between-group difference was observed with regard to the formation of an anterior temporal hollow (p = 0.000, chi-square test).

Illustrative Case

This 54-year-old man presented with a ruptured aneurysm of the right MCA and an unruptured aneurysm of the left MCA. A conventional pterional craniotomy involving a muscular cuff along the superior temporal line was performed on the right side to apply a clip to the ruptured aneurysm. Three weeks later, the cortical osteotomy technique was performed during a left-sided pterional craniotomy to treat the unruptured aneurysm. Six months after these procedures, a CT scan revealed a noticeable anterior temporal hollow on the right side, where the thickness of the temporal muscle had decreased by 30% in the anterior temporal area. Meanwhile, on the left side where the cortical osteotomy technique had been performed, no anterior temporal hollow was observed (Fig. 4).

Discussion

Although detachment and reconstruction of the temporal muscle are essential procedures to create a pterional free bone flap, these procedures cause muscle atrophy including disfigurement, contracture of the muscle with limited mouth...

TABLE 2
Development of an anterior temporal hollow in two groups undergoing different techniques of temporal muscle mobilization*

<table>
<thead>
<tr>
<th>Anterior Temporal Hollow Grade</th>
<th>No. of Patients</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Cortical Osteotomy</td>
</tr>
<tr>
<td>0, unremarkable</td>
<td>22 (24 patients)</td>
</tr>
<tr>
<td>1, mild</td>
<td>2</td>
</tr>
<tr>
<td>2, moderate</td>
<td>0</td>
</tr>
<tr>
<td>3, severe</td>
<td>0</td>
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</table>

*A statistically significant between-group difference was observed with regard to the formation of an anterior temporal hollow (p = 0.000, chi-square test).
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opening, and pain. The temporal muscle is often transected 1 cm below the superior temporal line to make a cuff of muscle, which is then reapproximated with sutures after completing the pterional craniotomy.5,9,12 After this procedure, however, a certain degree of atrophy and contracture of the temporal muscle occurs during healing of the injured muscle fibers.

Another way to mobilize the temporal muscle is to incise and take down the muscle sharply from its origin at the superior temporal line.1–4,6,7,11,13,15 Several techniques of resuspending the temporal muscle at the superior temporal line have already been described, such as drilling small holes in the bone flap and placing sutures through the holes1,3,4,6,7 or using screws and miniplates to anchor the detached temporal muscle.2,11,13,15 These methods involve points of fixation along the reconstructed areas, however, which can result in tears during muscle contraction.

In contrast, the novel technique of cortical osteotomy described here has the advantages of eliminating injury to the fibers of the temporal muscle and its muscular attachment to the bone along the superior temporal line, thereby avoiding atrophy and cicatricial healing of the transected muscle. Accordingly, the formation of an anterior temporal hollow is prevented, and the limited mouth opening is decreased. In addition, the cortical bone slat fixation with screws can provide optimal and secured restoration of the anatomy. Any malpositioning of the temporal muscle is avoided, and complete healing with bone fusion is achieved. Another advantage of the new technique is that the cortical bone slat covers the key hole and parietal burr hole defects, which can be another troublesome cosmetic problem (Fig. 5).

Conclusions

The novel cortical osteotomy technique for mobilizing and reconstructing the temporal muscle in pterional craniotomies minimizes damage to the muscle and eliminates key hole and parietal burr hole defects. As such, the proposed technique produces excellent cosmetic results and maintains better temporal muscle functionality with minimal additional operating time, while also providing a wide exposure.

References

2. Barone CM, Jimenez DF, Boschert MT: Temporalis muscle re-

Fig. 4. Computerized tomography scans obtained from the patient in the illustrative case. A: Preoperative CT scan. B: A CT scan obtained 6 months after bilateral craniotomies. An anterior temporal hollow is noticeable on the right side. The thickness of the temporal muscle is decreased by 30% in the anterior temporal area (solid circle). On the left side where the cortical osteotomy technique was performed, no anterior temporal hollow appears (dotted circle).

Fig. 5. Postoperative three-dimensional bone CT scans. A: The cortical bone slat along the superior temporal line covers the key hole and parietal burr hole defects. Three screws (arrows) were used to fix the cortical bone slat. Inset: Axial bone CT scan demonstrating a screw fixing the cortical bone slat to the secured bone flap. Note the oblique direction of the screw. B: Inside view of the skull demonstrating the key hole and parietal burr hole (arrows) under the cortical bone slat.


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