Cosmetic and functional reconstruction achieved using a split myofascial bone flap for pterional craniotomy

Technical note

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Pterional craniotomy in which an interfascial temporal muscle flap is used provides excellent exposure for the treatment of parasellar tumors, aneurysms of the circle of Willis and upper basilar artery, and tumors or arteriovenous malformations in the anterior temporal lobe. However, the interfascial pterional craniotomy requires dissection between the bone and the temporal muscle and between the temporal fascia and the skin, which can result in temporal muscle atrophy and paralysis of the frontotemporal branch of the facial nerve. In addition, atrophy of the free bone graft may result in the occurrence of bone pits along the line of the craniotomy. Several alternative methods have been described to prevent temporal fossa depression and to preserve the frontotemporal branch of the facial nerve; however, previously there has been no way to achieve both a wide exposure and an excellent cosmetic result by using Yasargil’s interfascial pterional craniotomy, without limiting the operative field with a bulky temporal muscle flap.

KEY WORDS • bone flap • operative technique • pterional craniotomy • temporal muscle

Operative Procedure

The skin incision is made 1 cm anterior to the tragus at the upper border of the zygomatic arch. It is extended anterosuperiorly in a curved fashion, ending at the midline just posterior to the hairline. Subgaleal dissection of the skin flap is performed to the line described by Yasargil, which is drawn between a point approximately 4 cm above the orbital rim medially and a point at the zygoma laterally. The subgaleal space of the anterior one fourth of the temporal muscle in the region of the frontotemporal branch of the facial nerve is left undissected. Dissection is not performed between the superficial and deep layers of the temporal fascia because the frontotemporal nerve sometimes courses within the interfascial space; instead, they are cut together along this line. An incision is made in the pericranium of the frontal bone medially. It is continued upward and backward along the craniotomy line, ending at a point 2.5 cm below the superior temporal line (Fig. 1A). A burr hole is planned at this location. Subperiosteal dissection is performed toward the orbital rim. The inner temporal fascia is incised along its attachment to the medial surface of the zygoma and frontozygomatic process, and the scalp flap is reflected anteriorly and downward. Two burr holes are drilled: the first above the frontozygomatic suture, just behind the zygomatic process, and the second in the temporal bone as previously mentioned. Using a craniotome, a bone incision is made along the anterior margin of the pterional bone flap between the two burr holes. Using a Gigli saw, a vertical linear bone incision is then made between the two burr holes, leaving a thin layer uncut, which is attached to the temporal muscle. This prevents muscle injury that may be caused by the sawing maneuver (Fig. 1B). The upper ante-
The anterior two thirds of the pterional bone flap is thus elevated, fractured along the linear craniotomy line, and reflected together with the temporal muscle. The lower portion of the temporal muscle is dissected subperiosteally, in a retrograde fashion, from the rest of the pterional bone flap, which is removed as a free bone flap (Fig. 1C). Because the temporal muscle is not tightly adherent to the bone below the inferior temporal line, the subperiosteal dissection is easily performed. The lateral sphenoid wing is further removed if necessary (Fig. 1D). After the intradural procedure, the free bone flap is first affixed to the posterior edge of the craniotomy by using miniplates (Fig. 2A). The anteroinferior portion of the myofascial pterional bone flap is then affixed to the anterior edge of the craniotomy (Fig. 2B). The two bone flaps are not joined together, but are tightly affixed to the skull by using two miniplates on each flap. There have been no problems with stability encountered using this method. The bone gaps and burr holes are filled with bone dust and fibrin glue, which facilitates osteogenesis and prevents the creation of bone pits. The incised temporal fascia is sutured tightly. Skin closure is performed in the usual fashion.

**Discussion**

Yaşargil, et al., first described the interfascial pterional approach in which the bulky temporal muscle is retracted backward, providing maximum exposure of the skull base. Since that time, pterional craniotomy has been the most widely used approach for treating cranial base lesions. This method, however, is associated with a risk of injury to the frontotemporal branch of the facial nerve. The anatomy of the facial nerve in relation to the pterional approach has been extensively discussed. The frontotemporal branch of the facial nerve emerges from the parotid gland, crosses the zygoma in the deepest portion of the temporoparietal fascia, and commonly runs into the subgaleal space. Sometimes it courses into the interfascial space. Dissection of the temporal muscle and skin as one flap would, therefore, minimize the risk of injury to the frontotemporal branch of the facial nerve. The anatomy of the facial nerve in relation to the pterional approach has been extensively discussed. The frontotemporal branch of the facial nerve emerges from the parotid gland, crosses the zygoma in the deepest portion of the temporoparietal fascia, and commonly runs into the subgaleal space. Sometimes it courses into the interfascial space. Dissection of the temporal muscle and skin as one flap would, therefore, minimize the risk of injury to the frontotemporal branch of the facial nerve.

Cosmetic deformities after pterional craniotomy can also be caused by atrophy or improper positioning of the

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**Fig. 1.** Schematic diagrams showing steps of the craniotomy. A: Following skin incision and subgaleal dissection, the temporal fascia and pericranium are incised (two-headed arrow). B: Subperiosteal dissection is performed toward the frontal base (broken arrows). For further retraction, the inner temporal fascia is partially incised on the medial surface of the zygoma (curved arrow). After two burr holes have been created and the anterior bone margin is cut in a curved fashion, the anterior two thirds of the bone flap is freed using a Gigli saw. C: Following posterior retraction of the myofascial bone flap and subperiosteal dissection of the posterior portion of the bone, the residual free pterional bone graft is cut in a curved fashion (arrows). Subperiosteal dissection is usually begun from below and then continued upward in a retrograde fashion. This lessens the risk of injury to the inner temporal fascia. D: The lateral sphenoid wing is drilled to expand the operative field (shadow).
temporal muscle. Oikawa, et al., have described dissection of the temporal muscle in a retrograde fashion, stressing that preservation of the periosteum and thus the deep temporal nerve and artery, is important to prevent muscle atrophy. To prevent improper positioning of the dissected temporal muscle, various fixation methods have been reported. In 1990, Spetzler and Lee described fixation of the temporal muscle performed using a muscle cuff that had been left behind during dissection of the free bone graft. Zager and colleagues used vicryl sutures and holes drilled into the bone graft. Miyazawa has used the fascia-periosteum complex. Reconstruction of the superior temporal line accomplished using methylmethacrylate is another option, although this requires significant experience.

Few reports contain descriptions of pterional craniotomy performed using a myofascial bone flap. This method preserves the blood supply to the bone, facilitating union and preventing atrophy. Schlitt and Quindlen have described an osteoplastic pterional craniotomy performed using a myofascial bone flap; however, in their procedure the problems of a limited operative field caused by the temporal muscle and lower edge of the myofascial bone flap have not been resolved. Sano and Shiokawa have reported a procedure in which they used a myofascial bone flap that involved zygoma removal. Their method provides good operative exposure, but is complex and is associated with a risk of facial nerve injury at the zygoma.

Our method was developed to resolve these problems and has several advantages. First, precise reapproximation of the temporal muscle is achieved by replacement of the myofascial bone flap. Second, because the area of subperiosteal dissection of the temporal muscle is small, the possibility of injuring the deep temporal nerve and deep temporal artery, which are the main innervation and blood supply to the temporal muscle, is minimized. Retrograde dissection decreases the likelihood of additional injury. In addition, because the deep temporal nerve courses within the deep portion of the muscle below the temporofrontal fascial plane, the consequences of partially cutting the superficial temporal fascia from the zygoma are minimal. Third, because dissection between the layers of the temporal fascia is not performed, the risk of injury to the frontal-temporal branch of the facial nerve is minimized. Finally, because blood supply to the anterior pterional bone flap is preserved, bone union is facilitated and atrophy is minimized. Using this method, a small bone gap is created between the anterior myofascial bone flap and the posterior or free bone graft. The gap is covered by the dense temporal muscle. We have not observed a deformity following this procedure.

Over the last 3 years, this method has been used to achieve excellent cosmetic and functional results in 40 patients without limiting operative exposure. In patients with a thin temporal muscle, it has been suggested that the temporal muscle and skin should be dissected as one flap. An orbitozygomatic craniotomy has been suggested for use in patients having a thick temporal muscle. Our method, however, can be used regardless of the thickness of the temporal muscle. Because it is not time consuming to create the two bone flaps and graft, this procedure is recommended for all patients in whom a pterional approach is required to treat cranial base lesions.

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