Discussion of Effect of Reflection of Temporalis Muscle During Cranioplasty With Titanium Mesh After Standard Trauma Craniectomy

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This is an invited discussion of an article by Jin et al[1] entitled "Effect of reflection of temporalis muscle during cranioplasty with titanium mesh after standard trauma craniectomy" that is published in the journal. In summary, their nonconsecutive case series of 39 patients receiving titanium mesh cranioplasty following standard trauma craniectomy (STC) describes a retrospective analysis of nonrandomized, noncontrolled outcomes for those receiving reconstruction with or without temporalis muscle reflection. Their study concluded that both methods of temporalis management with cranioplasty could improve cerebral blood flow and neurologic function, but that the cohort receiving muscle reflection—to a new position overlying the mesh—demonstrated improved recovery, acceptable temporal symmetry, and comparable complication rates. Unfortunately, this study is neither standardized nor randomized—and thus there is no evidence that their conclusions are justified. In addition, there are several concerns worth mentioning in relation to their surgical method—simply in an effort to stimulate meaningful studies moving forward.

One of the country's first modern-day cranioplasties—reported in the late 19th century by Drs Curtis and Booth[2]—describes the successful use of an aluminum plate to achieve delayed cranial reconstruction in a patient suffering from tuberculosis. On postoperative day 19, the neurosurgeon from New York raised a full-thickness scalp flap away from the dura and placed the bone substitute into place. Surprisingly, this type of cranioplasty approach has remained relatively unchanged—past down from generation to generation. Of note, however, our team at Johns Hopkins recently developed an improved method referred to as the "pericranial-onlay cranioplasty technique"—which employs an entirely different dissection plane.[3] It aims to preserve a protective barrier of vascularized tissue (ie, pericranium) above the dura in the area of missing bone, and therefore requires the reflection of a brand new, fasciocutaneous flap containing skin, subcutaneous tissue, and galea aponeurosis (based on the superficial temporal artery system). This new partial-thickness scalp flap is then reflected into a tension-free position over any medium of choice including autologous bone or customized implant.

The galea aponeurosis is a strong fascial layer within the middle of the scalp—contiguous with the superficial temporal fascia. Below that, is the hearty pericranium encasing the skull. However, the pericranium runs in deep parallel to the galea—and is contiguous with the deep temporal fascia covering the temporalis muscle (Fig. 1). Therefore, if one follows the "pericranial-onlay technique" as described, they are able to dissect within a single, seamless tissue plane—spanning above both the pericranium and scarred down temporalis muscle. However, Jin et al are supporting an entirely different approach—one in which mobilizes the entire temporalis muscle away from the dura and reflects it into a new position covering the outside surface of the titanium mesh. This type of dissection unfortunately puts one at higher risk for encountering dural injury, seizures, and increased blood loss.

To some, this type of reflection may also accompany additional concern—since temporalis muscle mobilization requires one to disrupt and cauterize any beneficial neoangenesis that may have occurred in the preceding months following intracranial injury and STC (ie, neovascular connections between the muscle and injured brain parenchyma, in instances when the dura is not closed). In fact, this concern would be well supported by the literature describing indirect vascularization for moyamoya patients using the temporalis muscle and the superficial temporal artery system.[4] Thus, our opinion is that for the sake of minimizing risk one should avoid temporalis muscle reflection altogether—as opposed to what is being highlighted in this article by Jin et al.

From a plastic surgery perspective, the goal of cranioplasty is not only to provide strong neurologic protection, but to restore our patients to their "preoperative appearance"—free of any visible contour irregularities for which can be easily noticed in the temporal region of the face. This, in turn, requires the detail-oriented reconstructive surgeon to acknowledge the various tissues at harm's way following STC and to prevent/correct all forms of "persistent temporal hollowing" during secondary cranioplasty. Therefore, for the artist/surgeon hoping to achieve long-lasting, durable results—one would prefer to employ a sculpture medium "constant and fixed," as opposed to one that alters with respect to time. Therefore, we are not quite sure of the conclusion noted by Jin et al in relation to achieving ideal cranial index of symmetry (CIS) following temporalis muscle reflection. In fact, their group reports that "in the present study, CIS score of patients in cranioplasty without reflection of temporalis muscle was 97.72 ($\pm$ 1.69%) while 97.97 ($\pm$1.53%) in the patients in cranioplasty with reflection of temporalis muscle." Equally concerning is that the maximum duration of follow-up was limited to just 3 months and the fact that there are no postoperative photographs shown of the temporal region.

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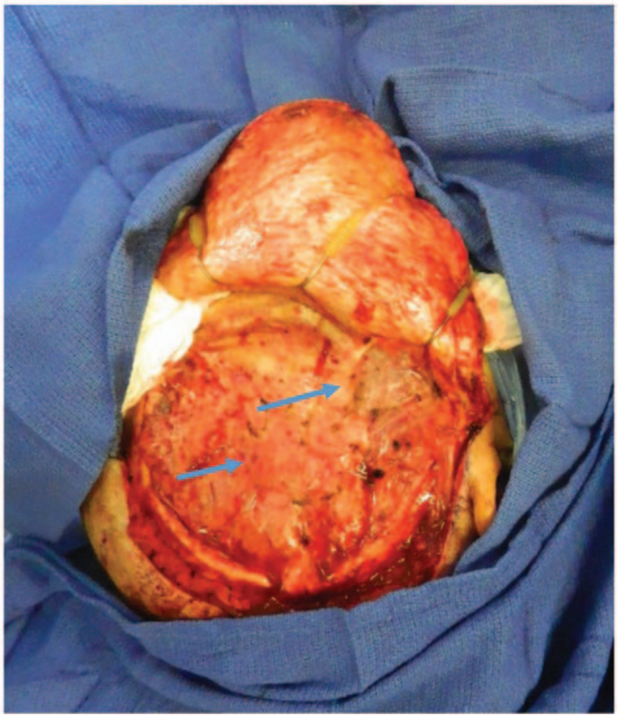

FIGURE 1. Intraoperative photograph of right-sided, hemicraniectomy defect dissection demonstrating the single, seamless tissue plane encompassing both the deep temporalis fascia (which encases the temporalis muscle) (top arrow) and the vascularized pericranial-onlay dissection within the boundaries of the cranial defect (bottom arrow).

For those who perform cranioplasty frequently, it is well known that transient "postoperative temporal edema" is common, and may take up to several weeks/months to self-resolve. As such, limiting patient follow-up to just 90 days seems suboptimal for any study evaluating CIS postcranioplasty. For example, in this paper, the clinical examination observed in all patients (Group A without temporalis muscle reflection and Group B with muscle reflection) could both appear full and symmetric in comparison to the non-operated temporal side. But in the cohort labeled Group B, for whom received temporalis muscle reflection, it would be safe to assume that the transposed muscle would be camouflaged by postoperative edema early on, and that it will eventually suffer some degree of atrophy secondary to relative ischemia, deinnervation and disrupting forces of mastication. Therefore, we are not sure how one can interpret the results provided in this interesting article.

In contrast, our team's approach is quite different—and instead preserves the temporalis muscle within its "scarred down" position. Instead, we augment the temporal region using a dual-purpose, patient-specific craniofacial implant placed above the fixed muscle—thereby avoiding implant fixation to the caudal aspect of the cranial defect.[5] In this way, the modified implant provides an outer contour strategically bulked in the temporal region to accommodate for any volume losses involving the temporalis muscle, temporal fat and/or bone—using computer-assisted design/computer-assisted manufacturing design as similarly noted by Jin et al[1] in their article. Furthermore, this type of design helps to avoid having to reflect the temporalis muscle and attaching it the outer surface of the titanium mesh with suture—since the remaining temporal muscle bulk following atrophy is hard to predict in the long term (as opposed to the nonoperated side). Also, one would assume that a dual-purpose implant made of either poly-methyl-methacrylate, poly-ethyl-ethyl-ketone, or porous polyethylene (Medpor) would have a more constant shape/contour for long-term symmetry versus a skeletonized muscle straddling the outer limits of a titanium mesh construct.[6] Furthermore, this method of cranioplasty reported by Jin et al. does not account for the iatrogenic temporal volume loss following STC dissections—leading to temporal fat pad atrophy and/or underlying bone flap resorption—which also contributes in some regards to the persistent temporal hollowing deformity being reported with an incidence approaching 52%.[5–7]

Either way, the team from China who conducted this institutional review board-approved study should be commended for their dedication in investigating the controversies surrounding temporalis muscle reflection in cranioplasty. We applaud them for their efforts in investigating their outcomes from an objective standpoint and for including validated outcome tools such as CIS, transcranial Doppler ultrasonography, and functional independence measurements. Future investigation in cranioplasty—with this type of objectivity—is undoubtedly warranted so that neurosurgeons and craniofacial surgeons may work together in unison to improve outcomes for those requiring emergent cranial decompression. More than ever, our patients seek full restoration back to their pretraumatic appearance following secondary cranioplasty—and therefore, any study like this by Jin et al is immensely valuable in our fight to eradicate the persistent social stigmata commonly associated with visible contour deformities secondary to temporalis muscle malposition.

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