The goals of the study by Jimenez, et al., were to define the effectiveness and the complications associated with the treatment of 139 patients with sagittal synostosis who had undergone endoscopy-assisted wide-vertex craniectomies and barrel stave osteotomies. These infants were treated with postoperative molding helmets for 1 year. They ranged in age from 2 weeks to 9 months. The authors report that visually the results were uniformly excellent and corroborate this by using cephalic index measurements. They also describe no significant complications, with the need for blood transfusion in only two patients intraoperatively and 12 patients overall. The indications for transfusion were a hematocrit of less than 19 and a pulse rate greater than 170. Most patients were discharged on the 1st postoperative day (132 patients [95%]).

Before one concludes that this is the optimal treatment of patients with sagittal synostosis, some additional factors need to be clarified. First, the authors state that there were no dural tears nor intracerebral hemorrhages or air emboli. On the surface, this approach has a significant number of appealing features: a smaller or less conspicuous scar in childhood, shorter operating time, and overall low morbidity rate.

Before one concludes that this is the optimal treatment of patients with sagittal synostosis, some additional factors need to be clarified. First, the authors state that there were no dural tears nor intracerebral hemorrhages. The authors did not, however, report a routine evaluation of the children’s skull and brain by using objective measures, such as computerized tomography (CT) scanning, in the immediate postoperative period to define this. The incidence of intracranial hemorrhage therefore cannot be stated based on the information provided because some of these complications may be “silent.”

The endoscopic approach—which I have used, on occasion, with a rigid endoscope—as the authors have described, restricted visualization, particularly laterally, in the basal skull. In the abstract, the authors describe that they have performed temporal barrel stave osteotomies, which would require crossing a patent squamosal suture. In most children, this requires a significant depression of the surface contour of the dura and underlying brain because of the convex nature of the frontal, parietal, and temporal lobes. In the body of the text, however, the authors indicate that the barrel stave osteotomies come to the level of the squamosal suture, and it is unclear based on the abstract whether the craniotomies are beyond the suture. It is probable with the use of scissors, which the authors describe as their cutting instrument, that at some point either a significant depression of the brain and contusion of the brain surface or dural laceration and hemorrhage could occur.

The third issue relates to the width of the craniectomy. The authors state that the mean width of the craniectomy defect is routinely 5.4 cm, with a skin incision line of 2 to 2.5 cm. This would mean that all the bone would have to be cut at least in half, if not thirds, to remove the bone segments. This would also indicate that the incision lines would tend to be more than 2.5 cm long (the photograph in Fig. 3F suggests that this scar may be longer than 2.5 cm, at least in some cases).

Concern regarding the long-term consequences of a large defect over the sagittal sinus is also raised. In cases in which this amount of bone has been removed in my own practice, thinner or incomplete bone formation occurred years later. The vertex of the skull produces a less effective remineralization of the cranial defect compared with frontal and temporal regions. The authors do not describe the extent of remineralization of the defect area nor do they provide any CT scanning evidence of the thickness of regenerated bone in this region. This is important because one needs to judge whether the skull is going to be sufficiently thick and durable to allow for normal childhood activities and participation in sports later in life.
In my own clinical practice, because small but sometimes continuous hemorrhaging occurs at the cut edge of bone 2 or 3 days after surgery, discharging patients on the 1st postoperative day may not be advisable.

A major difference between the endoscopic operative procedures and the comprehensive calvarial vault remodeling (CVR) approach is the fewer osteotomies required in the former. The authors report that they do not address the frontal bossing or occipital nob deformities regularly associated with sagittal synostosis. Instead, they rely on helmet therapy in the postoperative period. The authors of earlier studies, however, have shown that the wide-vertex sagittal strip craniectomy approach alone is not as effective in normalizing skull shape compared with the more comprehensive CVR approach.1 Adjunctive helmet therapy clearly does allow for the potential for further improvement postoperatively. My colleagues and I have advocated the use of skull molding helmets as an adjunct to surgical treatment.23 The helmets do have drawbacks, however. They are required to be custom made to the individual skull shape irregularity. The helmets also must be modified on a regular basis as the child grows. The authors describe that three helmets are necessary to achieve the desired skull shape. The use of individualized helmets may be very costly—in fact in some cases, it may exceed the professional fees associated with the surgery. There is also the need for the family to return to the occupational therapist’s office frequently for the necessary helmet adjustments. Even in these cases, however, it is unclear whether the results of the endoscopy-assisted craniectomy are favorable compared with those of the CVR technique. The cephalic index, as the authors note, is a relatively crude measure of overall shape, and subtleties such as bitemporal narrowing, bossing of the frontal bone, and nobbiness of the occiput are not addressed. Additionally, the authors’ methodology in determining cephalic index requires further clarification. Performing cephalometrics on radiographs and CT scans introduces a certain margin of error that is relatively minor if performed by skilled examiners on a repeated basis. When one determines a cephalic index in mobile patients, incorporating compressible soft-tissue measurements and ill-defined measurement landmarks, the potential for significant measurement variance is more likely. In this study, there were no error bars or repeated-measure testing performed to define intra- and interrater error for measurements. Postoperative three-dimensional cranial CT scanning might provide this analysis.

A potential advantage of this endoscopic approach is that the scar is shorter and less visible. Coronal incisions involved in comprehensive CVR are commonly associated with a prominent scar, particularly in the temporal area. Despite zig-zag and more posteriorly located incisions, the scars are often quite visible. The two incisions required in the endoscopic approach, one anteriorly and one posteriorly, however, in the long-term may be problematic. Particularly in males, if there is hair loss with time, the anterior incision scar is in the area where hair recedes early, and it would be very difficult to hide this without hair restoration techniques. The parietooccipital approach also is associated with hair loss but is common to both surgical approaches. In effect, the advantage of the small scar in childhood may not be quite as evident in the long term in males.

Another potential advantage of the endoscopic approach is that very few blood transfusions are necessary. This, too, appears to be advantageous. The indications, however, that the authors use for blood transfusion are a hematocrit of less than or equal to 19 or a pulse rate of greater than 170; these criteria are reasonably aggressive given the potential for life-threatening blood loss. If there is slow but active bleeding in an infant with a hematocrit of 19, there may be a significant delay between the time the low hematocrit is appreciated and the time the blood is actually transfused. The blood loss may have become even more severe, and a delay in treatment might be life threatening. The authors, however, are to be commended for the absence of death or significant problems; in their hands, the risks are relatively low. In other hands, however, such risks may not be as effectively avoided, and a higher hematocrit level may be considered a safer criterion for transfusion.

The authors state that there were no intraoperative air emboli. They did not, however, undertake Doppler-based study of all the infants undergoing surgery. Even in supine positioning, air emboli are regularly seen even in cases involving frontal craniotomies. They are usually hemodynamically insignificant, but Doppler signals may alert the surgical team to the increasing potential for more significant changes to come. Measures such as dependent head positioning and control of venous bleeding sites may be undertaken. It would be helpful to know the fluid-loading therapy administered prior to skin incision to lessen the likelihood of an air embolus intraoperatively.

As the authors report, titanium and metal devices, which were used in pediatric craniofacial surgery, have been replaced by resorbable plates and screws; thus, their attendant problems are no longer a concern in today’s treatment of infants with craniosynostosis.

In summary, I maintain that the endoscopic approach is promising; however, additional results are needed before it can be reported to be as safely and effectively done as current treatments of craniosynostosis. Specifically, I believe that the visualization apparatus needs to be improved by additions such as flexible fiberoptics with potential for cautery to control bleeding. Costs for skull molding caps should be decreased. Finally, objective reproducible comprehensive measurements of the efficacy should be used as the gold standard in determining which procedure results in the best correction of skull deformities.

References


RESPONSE: We appreciate the opportunity to address the concerns expressed by Dr. Persing in his editorial comments regarding our endoscopic approach to treat craniosynostosis. Anyone who has used an endoscope can ap-
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precipitate the fact that it provides excellent magnified, close-up visualization of the surgical field. Endoscopes certainly allow for superior visualization of the dura–osseous interface when the dura is being separated from the overlying bone, compared with the blind dissection necessary in traditional techniques. In fact, we found the endoscopes to be invaluable in avoiding injury to the sagittal sinus in several instances. In these cases, medium to large perforating veins, extending directly from the sinus into the diploic space, were visualized, exposed, cauterized, and sectioned without any adverse effects or injury to the sinus. At the end of each procedure, the dura is inspected using an inverted 30° endoscope and dural or cortical injuries (or the lack thereof) are documented. None has been found. We have, indeed, assumed that there were no intraparenchymal injuries. Given the fact that none of the patients exhibited clinical signs of such injury, however, our assumption stands, as it would have been the case with the traditional open surgery. Therefore, we found it unnecessary to expose the patient to the additional radiation of a cranial CT scan.

As we described in the article, once the vertex craniectomy is performed, the barrel stave osteotomies are created in the vicinity of the coronal and lambdoid sutures, but not at the level of the suture. A curved malleable brain band is directed toward the squamosal suture to dissect the dura. The curved Mayo scissors are used, likewise, to develop a subgaleal plane directly over the proposed osteotomy site. The scissors are used to create a wedge osteotomy extending to, but not across, the squamosal suture. Because this suture is patent, we find it imprudent to extend the osteotomy beyond it and therefore unnecessarily risk dural or intraparenchymal injury. With the bone wedge removed, the endoscope can be advanced without placing undue pressure on the brain, despite its convex shape. The Mayo scissors are 5 mm thick and the endoscope diameter is 4 mm. We believe that any depression caused by these instruments still places less pressure on the brain than that which is applied when the anteroposterior dimension of skull is actively decreased and compressed (such as in a π procedure) and during which elevation of the intracranial pressure has been documented.

As to the notion of reossification of the skull, our experience in more than 300 patients is in direct contradiction to Dr. Persing’s. The dura over the midfrontal and temporal areas seem to have significantly less regenerating capacity than the vertex. Thus, when performing metopic or coronal osteotomies, we restrict the osteotomies to a size no greater than 7 mm. By contrast, we have found complete vertex reossification in all of our patients. Bone regenerating capacity of the dura is inversely proportional to the child’s age, and the infant’s system is known for its capacity for full reossification. Because we are principally operating in infants, reossification, or the lack thereof, has not been an issue.

The width of the craniectomy can be up to 7 cm, yet by longitudinally fracturing the bone into two or three fragments, the entire segment can be removed without making larger scalp incisions. Because bone is not being replaced, it does not matter how many segments of bone are created to facilitate its removal. Similarly—regarding the location of the incisions—we fail to see how a 2- or 3-cm incision made posterior to the standard coronal incision can be problematic in the long term. In our older patients, the scars are hard to find, and if the male patient does become bald, is it better to have a 2- to 3-cm scar or a 20-cm coronal incision? Any surgical procedure to access the cranium or the brain will leave a scar, which may be noticeable with a receding hair line. In any case, we believe that smaller is better.

Because bone regeneration is not supplied by the osseous edges, we aggressively cauterize the cut edges of the bone with suction electrocautery set at 50 W. This allows complete hemostasis of any diploic bleeding. We believe that this is key to achieving complete hemostasis and control of any postoperative bleeding. Consequently, discharging the patient during the 1st postoperative day is safe, and this practice has been corroborated by the fact that only one patient required rehospitalization for blood transfusion. We believe that postoperative helmet therapy is extremely valuable in achieving the excellent results in our patients. The cost of each helmet is $848 for a total cost of therapy of approximately $2500 after three applications. As such, it is less than the cost of a longer surgical procedure. Helmets do indeed correct any frontal bossing or occipital knobbing deformities without the need for aggressive or extensive surgical correction. The study mentioned by Dr. Persing involved 11 patients who underwent strip craniectomy and did not wear a postoperative helmet. Therefore, no comparison can be made with our present study.

Anthropometric measurements should be both accurate and reproducible. In 1981 Parkas11 posited that the reliability of such measurements is valid for statistical evaluation. Christophis, et al.,2 cited the cephalic index as the best method by which to assess alterations of skull proportions. Barritt, et al.,1 also advocated measuring the cephalic index with calipers for long-term evaluation of growth pattern. They found that the radiographic magnification is slightly greater in the anteroposterior projection, which slightly inflates the radiographic cephalic index compared with the true cephalic index. This is an issue in terms of standardization of cephalic index measurements. Jünger, et al.,4 reported that magnification is not an issue when using computed tomography scanning, although radiation exposure is, especially for follow-up purposes. In our study intrarater error could not be assessed because all the measurements were consistently performed by one of the authors who used the same spreading caliper instrument. Intrarater error could not be assessed because the study was not designed to retest the rater’s measurement of cephalic index. We assumed that the widely used cephalic index measurement involving spreading calipers in the hands of an experienced clinician was valid. It was a clinical decision to not expose these infants to the unnecessary radiation, nor to subject their parents to the economic costs of either head computerized tomography scanning or standard skull radiography for the application of cephalometry.

We admit that our criteria for blood transfusion are somewhat aggressive. It is justified, however, by the fact that on completion of the surgery, excellent and thorough hemostasis has been obtained and endoscopically documented. With this approach, 32 patients with hematocrit levels between 20 and 25 did not require blood transfusions and were safely discharged to home.

We chose to use the rigid endoscopes precisely because of their superior optics and visualization. Flexible fiberop-
tic scopes provide significantly less resolution and were therefore not used. The use of rigid endoscopes with suction electrocautery obviates the need for costly development of inferior fiberoptic scopes.

Informed consent implies that the parents should be presented with all reasonable and available surgical options. Given similar results, they should be the ones to choose between extensive surgeries and guaranteed blood transfusions, or short surgeries, minimal need for blood transfusion (10%), and year-long helmet therapy.

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References