

## Total calvarial reconstruction for sagittal synostosis in older infants and children

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✓ Premature closure of the sagittal suture is the most common form of craniosynostosis, but this condition occasionally goes unrecognized until the child is too old to undergo procedures that depend upon continued calvarial growth for success. As the entire calvaria is affected and thus misshapen by sagittal synostosis, late correction involves total calvarial reconstruction. The extensive nature of this undertaking has precluded its utilization despite the presence of significant deformities. Adapting the techniques and experience gained from craniofacial surgery, the authors performed total calvarial reconstruction on nine children with sagittal synostosis and subsequent scaphocephaly diagnosed after the age of 1 year. In each case the goals of shortening the anteroposterior length, widening the biparietal diameter, and reducing frontal and occipital deformities were met. Morbidity consisted of acute blood loss, postoperative hyponatremia, and in one case a residual skull defect. The rationale for this procedure and the techniques utilized are discussed.

**KEY WORDS** • sagittal synostosis • craniosynostosis • scaphocephaly • operative techniques

**S**AGITTAL synostosis is the most common form of craniosynostosis and is usually easily recognized, even in early infancy. Unfortunately, either because of a failure to diagnose the condition early or because calvarial growth precipitates worsening of an initially mild deformity, some children with sagittal synostosis are not considered for surgical correction until after the age of 1 year. At this age, the calvaria has reached 85% of its adult size and procedures that depend upon continued calvarial growth for success, such as strip craniectomy, are of little value. Persing, *et al.*,<sup>16</sup> have shown that single suture synostosis causes deformity of the entire calvaria. Thus, correction of "late" sagittal synostosis would involve a total reshaping of the cranial vault. The extensive nature of this intervention and concerns with associated morbidity and even mortality have prevented corrective surgery in the older child with sagittal synostosis.

Since the development of craniofacial surgery in the 1960's by Tessier, significant advances have lowered morbidity and mortality rates and allowed the application of these techniques to an increasing variety of conditions. Persing, *et al.*,<sup>16</sup> previously described an innovative procedure for the correction of late sagittal synostosis derived from their extensive experience in craniofacial surgery. We describe our operative approach using a modification of their techniques and

our results in the treatment of children with late sagittal synostosis.

### Clinical Material and Methods

#### *Patient Population*

Since October, 1990, we have performed total calvarial reconstruction on nine children (six boys and three girls) ranging in age from 16 months to 5 years (Table 1). The characteristic stigmata of sagittal synostosis were present in each case: an elongated cranium, biparietal narrowing, and a protuberant forehead and occiput. Diagnosis was made by clinical criteria and confirmed by plain film radiography and computerized tomography (CT). Ten procedures were performed, as one child with a markedly elongated head required a two-stage reconstruction.

#### *Operative Procedure*

With the patient under general endotracheal anesthesia, either two large-bore peripheral intravenous lines or a central venous catheter is placed, as well as an intra-arterial line and a Foley catheter. The hair is shaved and the child is turned to the prone position with the neck hyperextended. Preoperatively, neutral and hyperextension lateral cervical spine radiographs are obtained to rule out anomalies that would preclude

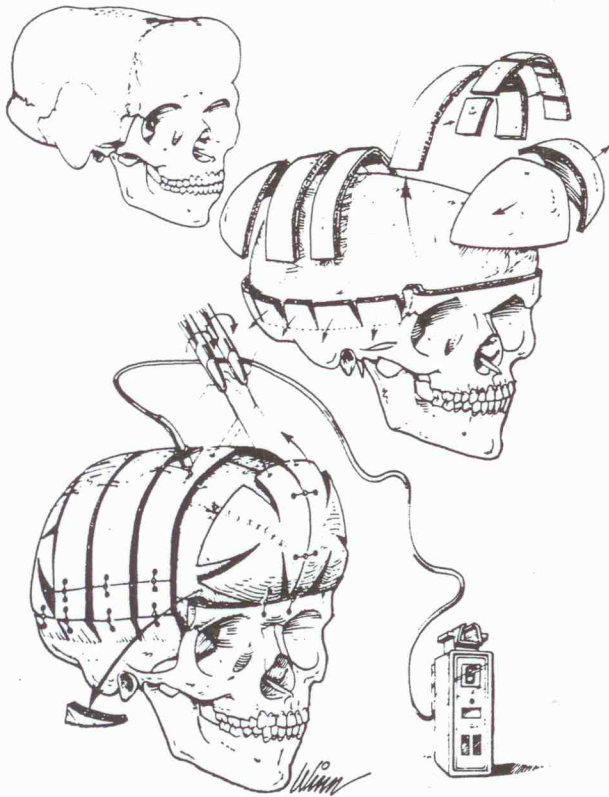


FIG. 1. Drawing illustrating the technique of total calvarial reconstruction for treatment of sagittal synostosis in the older infant or child.

prolonged use of cervical hyperextension. This position is maintained with the use of a Vac Pac positioning system.\* All pressure points, including the chin and cheeks, are well padded. After sterile preparation of the head, an incision is made across the vertex, and the subgaleal plane is dissected to allow elevation of the skin and galea below the occipital shelf posteriorly and at the level of the supraorbital ridge anteriorly. The pericranium is incised just above and following the contour of the temporalis muscle bilaterally and then across the vertex. This allows elevation of the pericranium in two flaps, one posteriorly and the other anteriorly. The temporalis muscle is elevated to complete the exposure of the cranial vault.

A bifrontal craniotomy is then performed with the supraorbital osteotomy positioned below the frontal boss (Fig. 1). The posterior osteotomy is placed in front of the coronal suture. The posterior frontal and parietal bones are removed in three bands of approximately equal width. The lateral osteotomies for these bands are performed just above the squamosal suture, and the osteotomy across the midline is accomplished via a midline burr hole. The occiput is then removed, with the posterior osteotomy positioned below the occipital

\* Vac Pac positioning system, size 11, manufactured by Olympic Medical, Seattle, Washington.

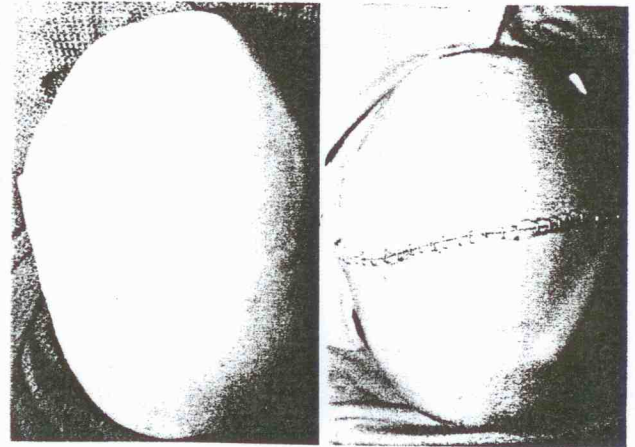


FIG. 2. *Left:* Preoperative photograph in Case 8, superior view with the nose to the bottom of the picture, demonstrating a markedly elongated cranium. Posterior asymmetry is caused by associated lambdoid synostosis. *Right:* Photograph taken immediately after surgery showing that the cranium is shortened in anteroposterior length and is wider biparietally and that the posterior plagiocephaly has been corrected.

shelf. A burr hole is placed in the midline of the occiput to facilitate stripping the dura from the bone.

The dura is dissected away from the temporal bone, and vertical cuts are made to allow out-fracturing of the temporal bone (barrel-stave osteotomies). Plication sutures are placed diagonally in the bulging frontal dura which reduces the anteroposterior length and the lateral frontal bulge of the dura. As the frontal sutures are placed, the parietal dura begins to bulge into the space created by the barrel-stave osteotomies.

As each segment of bone is removed, it is handed to the craniofacial plastic surgeon for reshaping. The frontal bone is split vertically in the midline, radial osteotomies are cut, and the bone is bent outward to correct the frontal boss. Microplates and screws are utilized to rejoin the two halves of the frontal bone. A wedge of bone is removed from the inferolateral frontal bone to allow it to tilt backward when repositioned on the supraorbital ridge, thus reducing the anteroposterior length. A similar technique is utilized to correct the occipital shelf. The parietal bands are grooved along their inner surface ("kerfing") and bent laterally with Tessier bone benders. Approximately 2 to 3 cm of bone is cut from the bands and used as graft material. These 2 to 3 cm constitute the anteroposterior reduction of the calvaria.

The biparietal bands are then placed back over the vertex. Bone is grafted laterally to close the gap created by the more convex bands and the out-fractured temporal bone. This procedure constitutes the biparietal widening. The bands and their grafts are fixed rigidly with microplates and screws; the parietal bone serves as a central pillar for fixation of the occiput and frontal bones.

The deformity of sagittal synostosis is frequently worse either frontally or in the occiput. If the forehead

