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Application of the Spanning Plate Concept to Frontal Orbital Advancement: Techniques and Clinical Experience in 60 Patients

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Frontal orbital advancement (FOA), is the procedure of choice in treatment of coronal and metopic synostosis. Resorbable plates and screws have been widely accepted for use in pediatric craniofacial surgery, including FOA. We have applied the concept of extended resorbable spanning plates to FOA for metopic, unilateral, and bilateral coronal synostosis in infants and children during a 5-year period. We report on 60 patients, ages 4 to 15 months (mean, 7 months); 28 girls, 32 boys. Follow-up ranged from 12 to 36 months (mean, 24 months). There were no structural failures, no infections, and no complications related to the use of extended spanning plates. Extended spanning plates decrease mobility between bone segments, confer greater stability to the construct, and reduce both the number of plates and of screws that are necessary and reduce the operative time. Application of these plates simplifies FOA surgery and represents a step in the evolution of plating technology.

Key Words: Synostosis, resorbable plates, frontal orbital advancement

The treatment for metopic and coronal synostosis has evolved from simple synostectomy to frontal orbital advancement (FOA), during the last century.[1,2] Friedenwald, in 1893, recognized that craniosynostosis was associated with optic atrophy and could lead to blindness.[3] Lane, in 1892, recognized the association between synostosis and mental impairment.[1] Synostectomy alone does not address the base of cranium or orbital deformities, and can result in incomplete correction of the orbitocranial deformity.[4,5] FOA addresses both the suture synostosis and the secondary orbital and cranial deformities. Techniques for FOA have evolved from wire fixation to rigid metallic fixation to resorbable fixation techniques.[6,7] Wire fixation requires interlocking osteotomy designs, such as the tongue-in-groove technique, for maintaining the advancement during bony healing. These techniques can be technically challenging and time consuming and allowing for the possibility of bony relapse. The application of rigid metallic fixation overcame the osteotomy design limitations and increased stability.[8,9] Palpable plates and screws, and migration of hardware into an intracranial position through the process of bone resorption and deposition can result when metallic fixation is placed on the growing cranium.[9] We have previously reported on the safety and efficacy of resorbable fixation systems in craniofacial applications.[7,10,12] Resorbable plates and screws eliminate many of the problems found with rigid metallic fixation and maintain structural integrity. The spanning plate concept was introduced by McCarthy et al. and first applied to treatment of scaphocephally.[13] Recently, Eppley et al. applied the spanning plate concept to a variety of conditions requiring total calvarial reconstruction.[14] These authors used spanning plates to facilitate extensive cranial vault reconstruction and stabilize multiple osteotomy segments. In this study, we extended and modified the spanning plate concept for use in FOA.

Materials and Methods

Sixty infants, ages 4 to 15 months (mean, 7 months), were operated on during an 8-year period. There were 28 girls and 32 boys. Three groups of patients underwent FOA, 22 had metopic synostosis, 24 had unilateral coronal synostosis, and 14 had bilateral coronal synostosis. Ten of the patients with bicoronal wsynostosis also had other associated syndromic findings. All underwent a standard combined

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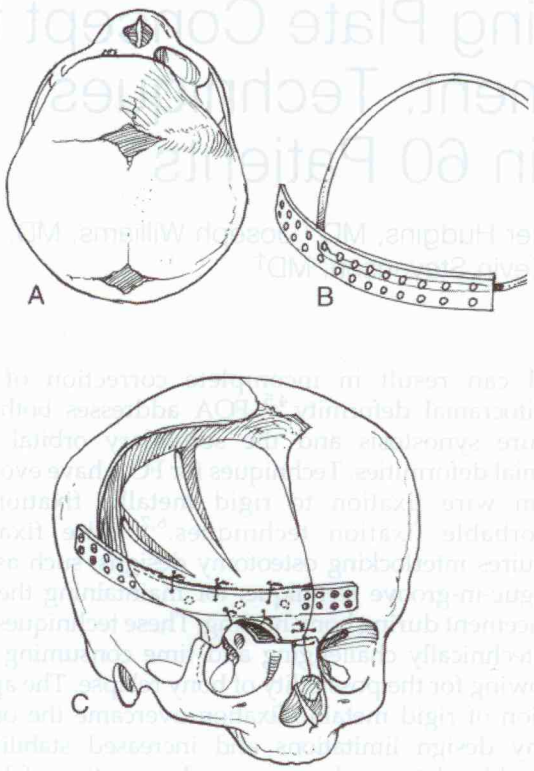

Fig 1 (A) Drawing of a right coronal synostosis. Note the frontal and orbital deformity. (B) Spanning plate that has been heated in a water bath contoured to an age-appropriate template. (C) Final construct with radial osteotomies of frontal bone, which is fixed to frontal orbital bandeau with fine wires for "float". The spanning plate creates the desired radius curve and provides stability.

neurosurgical craniofacial approach to FOA. After removal of the frontal bone and frontal orbital bandeau, osteotomies and bone contouring were used to achieve the desired correction on the back table Figs 1–3. A specially manufactured 240-mm-long, 1-mm-thick plate, with a double row of screw holes was used as a one-piece extended spanning plate for attachment of the frontal orbital bandeau, frontal bone, and bone grafts, as required Figs 1–3. In cases of metopic synostosis, the frontal orbital bandeau was osteotomized centrally and bone grafted as required to achieve the desired frontal width Fig 1. In unilateral coronal synostosis, an overlap of the frontal bone over the frontal bone was used to achieve optimal frontal contour Figs 2, 4. In bilateral coronal synostosis, both sides of the frontal bone were radially osteotomized contoured, and overlapped bilaterally Fig 3. These techniques were varied slightly depending on the severity of the deformity. In all cases, the spanning plate was heated in a thermal water bath and then contoured to a Marchac template appropriate for the patients age and overall head circumference Fig 2. This contoured spanning plate was then used as the central structural element for attachment of both the frontal orbital bandeau and frontal bone segments. When an overlap technique was necessary, the overlapped frontal bone was attached to the frontal orbital bandeau with either 28-gauge wire or resorbable screws. The entire construct was then returned to the operative field. A 28-gauge wire was passed through the frontal nasal juncture with a wire pass drill bit and the construct was attached via this wire to establish the midline and prevent a bucket-handle effect. With the midline established, the desired advancement at the lateral orbital osteotomy was determined and the spanning plate was attached to the temporal bone with three resorbable screws per side. The lateral canthus was suspended to the spanning plate, and the temporalis muscles were advanced and sutured to the frontal bone to prevent temporal hollowing. The scalp was closed

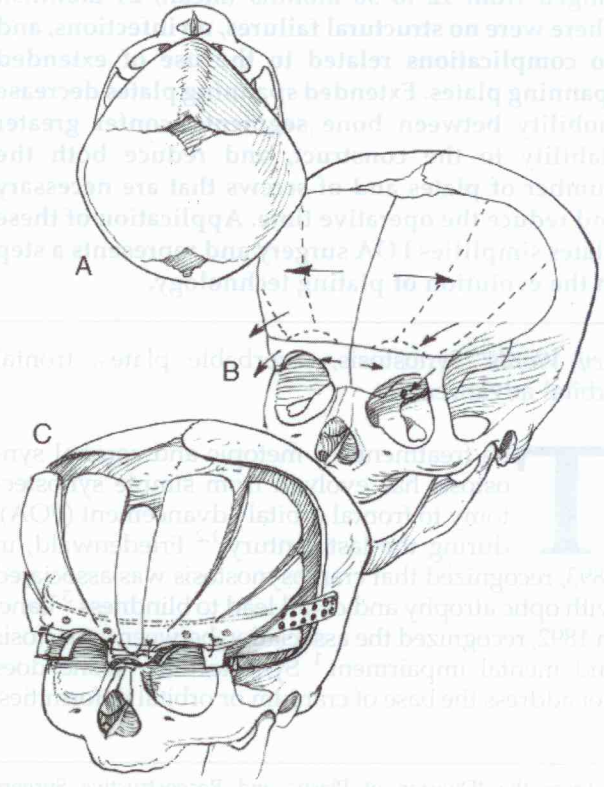

Fig 2 (A) Drawing of metopic synostosis with trigonocephaly. (B) Planned osteotomies with expansion of frontal bone and frontal orbital bandeau. (C) Final construct with overlap of frontal bone, radial osteotomies, and bone grafts for expansion as well as to fill the temporal fossa.