Lateral canthal advancement of the supraorbital margin

A new corrective technique in the treatment of coronal synostosis

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In coronal synostosis, in addition to fusion of the coronal suture, the frontosphenoidal and frontoethmoidal sutures are usually closed. A linear craniectomy along the coronal sutures does not affect the synostotic process at the base of the skull. The facility with which the supraorbital margin could be mobilized in Tessier's method of craniofacial repair suggested to us that we could easily modify our approach to coronal synostosis and advance the supraorbital margin, creating an artificial suture at the base of the skull and allowing for proper correction of this disorder. During the past 3 years, we have treated 15 patients with coronal synostosis by this technique, which we have termed lateral canthal advancement. The method of this form of surgical management and its results are discussed.

KEY WORDS • lateral canthal advancement • coronal synostosis • Crouzon's syndrome

FOR many years, the standard treatment of coronal synostosis has consisted of a linear craniectomy along the course of the coronal suture, sometimes combined with morcellation of the frontal bone. We and others have found the results of treatment of this condition unsatisfactory. Shillito and Matson in their extensive series of patients with coronal synostosis obtained an excellent result in only 62%. Many patients treated by this standard method for coronal synostosis have become candidates for a radical craniofacial repair in later years (Fig. 1).

Pathophysiology

In coronal synostosis, a significant number of patients have premature fusion of more than the coronal suture. Seeger and Gabrielsen pointed out that the frontosphenoidal and frontoethmoidal sutures were also closed (Fig. 2). Patients with a synostotic process in the base of the skull have a flattened forehead, a shallow anterior fossa, a thickened pterion, and a shallow orbit sometimes associated with proptosis. A linear craniectomy along the coronal suture does

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nothing for the synostotic process at the base of the skull and no doubt accounts for the poor results obtained in patients treated with a standard operative procedure for coronal synostosis. If one extends the cuts along the supraorbital margin as advocated by Anderson and Geiger, then the frontal bone is separated from the sphenoidal bone but the anterior fossa is left small and unable to expand because of the closed frontosphenoidal and frontoethmoidal sutures. Unfortunately, it is usually impossible to determine which patients with coronal synostosis also have closed frontosphenoidal and frontoethmoidal sutures; a technique should be used that would produce a reasonable result in all patients.

Ideally, for correction of this disorder in all patients with coronal synostosis, an artificial coronal suture must be made, the entire frontal bone separated from the base of the skull, and an artificial suture created in the base of the skull. This allows the frontal bone to be moved into normal position, thus expanding the anterior cranial fossa as well as allowing for its future growth.

In 1971, we began to carry out craniofacial repairs with our plastic surgery colleague in the treatment of a variety of craniofacial disorders. The facility with which the supraorbital margin could be mobilized in Tessier’s method of craniofacial repair suggested to us that we could readily modify our approach to coronal synostosis and advance the supraorbital margin to create an artificial suture at the base of the skull and allow for proper correction of this disorder.

FIG. 1. Left: Lateral skull x-ray film of 12-year-old girl with bilateral coronal synostosis treated by linear craniectomies in infancy and displaying a markedly deformed skull. Right: Lateral skull x-ray film following radical cranial repair of skull deformity.

FIG. 2. Drawing of base of skull in patient with left coronal synostosis. Heavy lines show closed frontoethmoidal and frontosphenoidal sutures.
Case Material

During the past 3 years, we have treated 15 patients with coronal synostosis by this technique, which we have termed "lateral canthal advancement." Ten of these patients had unilateral coronal synostosis with plagiocephaly and five had bilateral coronal synostosis.

Of those patients with unilateral coronal synostosis, seven were female and three were male. The left coronal suture was involved in four cases and the right in six. Five of the seven females had involvement of the right coronal suture and two of the three males had involvement of the left coronal suture. Two patients were treated before 4 weeks of age, three between 4 weeks and 3 months, four between 4 months and 1 year, and one at more than 1 year of age.

Of the patients with bilateral coronal synostosis, four were male and one was female. Three of the male patients and the female patient had Crouzon's disorder. Two patients were less than 1 month old at time of initial treatment and three were over 1 year.

Surgical Technique

After the patient is positioned supine and under general anesthesia with controlled ventilation, a bifrontal scalp flap is turned together with periosteum and reflected down into the orbit taking the supraorbital nerves with the periosteum and scalp flap.

In cases of unilateral coronal synostosis, a single large frontal bone flap is turned back to the closed suture and medially to the midline. In cases of bilateral coronal synostosis, a large bifrontal flap is turned back to the closed coronal suture, and the frontal bone flap removed. Cranietomy is now carried down into the greater sphenoid wing, removing the pterion. The orbital plate, which runs vertically because of the short anterior fossa, is exposed extradurally. The dissection is carried down into the orbit separating the orbital fascia from the inferior surface of the orbital plate, thus fully isolating the orbital plate. With the fine burr of a power drill, the orbital plate is incised just behind the supraorbital margin from the pterion to the crista galli (Fig. 3). This osteotomy is extended laterally through the frontozygomatic process; this completely frees the supraorbital margin, leaving it hinged only at the nasion medially. This particular attachment can be easily bent and the entire supraorbital margin is swung anteriorly, pivoting at the nasion and advancing the superior border of the orbit (lateral canthal advancement) (Fig. 4).

The lateral aspect of the supraorbital rim is then held in place by a horizontal bone graft taken from the frontal bone and wired in place to the parietal bone posteriorly and to
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the lateral extent of the supraorbital rim anteriorly (Fig. 5). Each frontal bone is divided into two fragments, rotated 90°, and replaced, usually held in place only by the periosteal flap.

If the procedure is done before the age of 15 months, the posterior limit of the frontal craniotomy is sheathed with Silastic sheeting. The strut of bone is wired through the Silastic to the underlying parietal bone. This strut, which initially stabilizes the supraorbital margin in the young infant, does not fuse with the underlying parietal bone because of the Silastic sheeting covering the parietal bone; thus the strut does not provide a tethering effect (Fig. 6).

Results

The results of this procedure have been extremely gratifying. Although other procedures for coronal synostosis provided an excellent cosmetic result in 50% to 75% of cases, with this technique we are able to achieve an excellent cosmetic result in all cases of unilateral coronal synostosis (Fig. 7). It is essential, particularly in the young infant, to advance the supraorbital margin by at least 10 mm. Early in our series, in one of the 10 patients with unilateral coronal synostosis in whom the operation was carried out at 2 months, the lateral canthal advancement was only 4 mm. This particular child was the only one in the group who achieved less than an excellent result; a further advancement at 2½ years achieved a satisfactory result. None of the other patients have required a second procedure and they all have a symmetrical forehead.

Fig. 5. Drawing of operative procedure showing strut holding supraorbital ridge in new position.

Fig. 6. Left: Lateral radiograph of skull in a neonate with Crouzon's deformity and closure of both coronal sutures. Center: Immediate postoperative lateral radiograph of infant with Crouzon's deformity showing the two struts in position, wired both anteriorly and posteriorly. Right: Same infant as in Fig. 7 left at 2 years showing tremendous growth forward of frontal bone, anterior fossa, and face. The wires have separated showing that the posterior wire is presumably pulled out of the strut because of a pseudoarthrosis posteriorly, produced by the Silastic.
The patients with bilateral coronal synostosis did not do as well as the patients with unilateral coronal synostosis; on the other hand, they did far better than with past techniques. Two of these children with Crouzon's deformity were treated during the first month of life. One was treated at 1 week with an advancement of 13 mm, and at 1½ years of age has a virtually normal appearance; there are no stigmata of maxillary hypoplasia and a craniofacial repair will probably not be needed in the future. The second patient was treated at 3 weeks (Fig. 8 left) with a 15 mm advancement. At the age of 1 year this child developed the typical stigmata of unilateral coronal synostosis with plagiocephaly and underwent a second advancement on only one side. Although as a newborn this child had the typical stigmata of Crouzon's deformity, he now looks perfectly normal aside from some congenital ptosis on the right (Fig. 8 right) and again may be saved from a future radical craniofacial repair. One child with oxycephaly had all of his sutures opened at 5 years of age, and presented at 9 years of age with the typical stigmata of bilateral coronal synostosis. He did not have maxillary hypoplasia and after a 20-mm lateral canthal advancement on both sides he now has a normal appearance.

The two other patients with bilateral coronal synostosis had minor degrees of Crouzon's deformity. One of these presented as an infant with sagittal synostosis and had an excellent result following treatment of this condition. At the age of 4 years, he presented with the typical signs of bilateral coronal synostosis and minimal maxillary hypoplasia. Rather than undergoing a radical craniofacial repair, his coronal sutures were opened and a lateral canthal advancement of 5 mm carried out, giving an excellent cosmetic result. The other patient with Crouzon's deformity had a lateral canthal advancement at 14 months; although it improved her appearance, she subsequently required a radical craniofacial repair which was carried out in cooperation with our plastic surgery colleague.

Discussion

Using the technique of lateral canthal advancement, we have achieved a satisfactory correction of the deformity of coronal synostosis. In addition to creating an artificial coronal suture, an artificial suture is created in the anterior fossa which provides for an orbital decompression and permits the expanding frontal lobe in the young child to move the forehead forward with growth. Tessier pointed out that congenital malformations of
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the cranial vault and the facial skeleton are associated with disturbances in the base of the cranium. In the two neonates with Crouzon’s deformity, we believe our method prevented maxillary hypoplasia and allowed the face to grow forward with the expanding frontal bone, thus avoiding the necessity for a radical craniofacial repair in later years. Ideally, whether coronal synostosis be unilateral or bilateral, it is best treated in the young infant by creating artificial sutures. Brain growth allows for continued proper expansion of the anterior cranial fossa and the underlying facial bones connected to the anterior cranial fossa via the sphenoid bone. We feel that lateral canthal advancement is ideal in cases of unilateral coronal synostosis where the deformed frontal bone can be lined up with the normal one on the other side.

In bilateral coronal synostosis without facial deformity, a bilateral canthal advancement can be carried out at any age with good results. However, in Crouzon’s deformity it is of value primarily in the young infant where release of the coronal sutures and basal skull sutures appears to allow the face to move forward with growth of the frontal lobe, allowing correction of the facial deformity at the same time as the skull vault abnormality. Unfortunately, if the child with Crouzon’s deformity has not had a proper repair of the coronal suture in infancy, the anterior fossa will remain small and consequently, the attached face will display significant maxillary hypoplasia so that a radical craniofacial repair will eventually be necessary.

References


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