

A Preliminary Investigation of Postoperative Molding to Improve the Result of Cranial Vault Remodeling

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ABSTRACT

Craniosynostoses most frequently require correction by craniotomy and cranial vault remodeling to facilitate neurologic development and normal cranial shape. Although the skull can be fairly accurately contoured intraoperatively, the final shape is dependent on many factors, including bone and brain growth and bone resorption. Although molding helmets have been used for positional head molding and in the management of endoscopic suturotomy, very few studies have evaluated their use in the postoperative care of patients undergoing open cranial remodeling. The authors sought to evaluate the use of postoperative helmet therapy after surgical correction for nonsyndromic single suture craniosynostosis. A retrospective review of six patients with nonsyndromic craniosynostosis who underwent cranial remodeling by a single surgeon with postoperative helmet therapy in 2003 and 2004 was performed. The four female and two male patients ranged in age from 5 months to 13 months at the time of surgery. All the patients were seen and measured by the same orthotist, and helmet therapy was begun 2 to 4 weeks after surgery. Postoperative helmet therapy lasted for 6 months. All patients showed an improved cephalic index when compared with the initial postoperative measurements. There were no adverse consequences associated with helmet therapy. Helmet therapy after craniosynostosis surgery improves cephalic index and skull shape beyond the results obtained at surgery. The authors conclude that postoperative helmet therapy is an effective treatment adjunct to craniosynostosis surgery for patients with nonsyndromic single suture synostosis. (*J Prosthet Orthot.* 2005;17:125–128.)

The value of helmet therapy in the treatment of dysmorphic cranial vaults has been well established.¹⁻³ In cranial deformities secondary to positional head molding, the use of helmets to improve the flattened areas of the skull can be quite dramatic.³ However, this success is dependent on the rapidly growing brain pushing out the immature cranial vault in those areas allowed by the helmet.

More recently, helmets have been increasingly used after endoscopic cranial vault surgery.^{4,5} In this process, the fused suture is resected and a limited number of osteotomies performed. The patient is then placed immediately in a conforming helmet to help mold the surgically treated skull into the desired shape because no substantial reshaping is performed during surgery. When performed at a very early age, the results from this technique have been promising. However, very few authors have used helmets after surgery in patients who have undergone radical cranial vault remodeling, ostensibly because the addition of the helmet was deemed unnecessary once the osteotomized cranial vault had been shaped appropriately. The current article reviews a series of patients undergoing standard cranial vault remodeling for single suture synostosis via a coronal approach with frontal orbital advancement with cranial reshaping. All patients were placed into helmets immediately after surgery, with accurate documentation of skull shape recorded before and after treatment.

PATIENTS AND METHODS

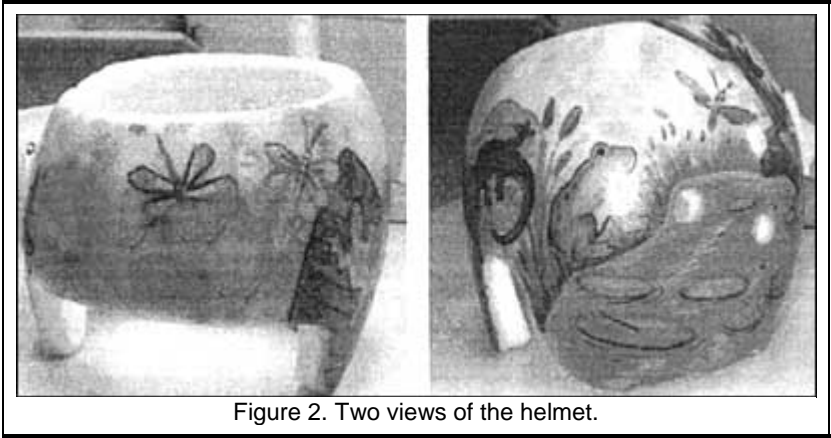
Six patients underwent cranial remodeling with postoperative helmet therapy from 2003 to 2004. All patients had a diagnosis of nonsyndromic craniosynostosis. Two patients had metopic synostosis, two patients had left unilateral coronal synostosis, one had bilateral coronal synostosis, and one had a right unilateral coronal synostosis. The patients' ages at the time of operation ranged from 5 months to 13 months. The patients were evaluated and measured by the same orthotist, and helmet therapy was begun 2 to 4 weeks after surgery. Measurements were recorded, and the cephalic index was calculated using the formula (head width / head length X 100). The cephalic index is a proportion of the width of the head to the length of the head. The cephalic indices were compared with the normative data described by Farkas.^{6,7} A cephalic index of 78% was used as the ideal value. Measurements were performed using a caliper and included cranial

circumference, skull base, cranial vault, orbitotragal depth, head width, and head depth (Table 1). Patients had serial visits to the orthotist for measurements and adjustments at 3-week intervals, and helmet therapy lasted 4 to 6 months.

Measurement	Definition
Skull base asymmetry	Difference between the two measurements taken from subnasal to right and left tragus respectively
Cranial vault asymmetry	Difference between the two measurements taken from right excantion to left eurion and from left excantion to right eurion
Orbitotragial asymmetry	Difference between the two measurements obtained from the right excantion to the right tragus and from the left excantion to the left tragus
Cranial width	Left eurion to right eurion
Cranial depth	Glabella to inion
Cephalic index	Cranial width divided by cranial depth
Cranial Circumference	Circumference taken at the equator of the head approximately 1 cm above the eyebrows

Table 1. Measurements recorded by the orthotist

Two to 4 weeks after surgery, a plaster mold was made by the orthotist. The plaster served as a template for the helmet (Figure 1). The helmet was made of 3/8 inch co-polymer thermoplastic with an interface foam of 1/2 inch closed cell pelite (Figure 2). During the orthotist follow-up visits, adjustments were made to relieve any areas of impingement. The helmet fit was closely monitored to ensure the treatment strategy was maintained. Gradual removal of the foam interface material allowed for these regular adjustments. Care was taken to ensure proper clearances of the patient's ears and allowed the patient a reasonable visual field. The orthotist verified intimate contact of the helmet in areas where growth constraint was desired and sufficient clearance where corrective growth was desired. The family was instructed how to perform daily skin checks and other pertinent caregiver instructions. The helmet was kept on the patient for a total of 23 hours a day.



RESULTS

All patients had an improved cephalic index compared with initial measurements taken after surgery (Table 2). In addition, all patients demonstrated an improvement in subjective skull contour when evaluated by the surgeon (Figure 3 and Figure 4). No complications were attributed to the use of postoperative helmet therapy.

Patient	Diagnosis	Post-op C.I.	Post-helmet therapy C.I.
1	Metopic Synostosis	93%	88%
2	Metopic Synostosis	104%	92%
3	Left Coronal Synostosis	85%	84%
4	Left Coronal Synostosis	81%	80%
5	Right Coronal Synostosis	85%	84%
6	Bilateral coronal Synostosis	90%	86%

Table 2. Postoperative cranial indices (C.I.) before and after helmet therapy

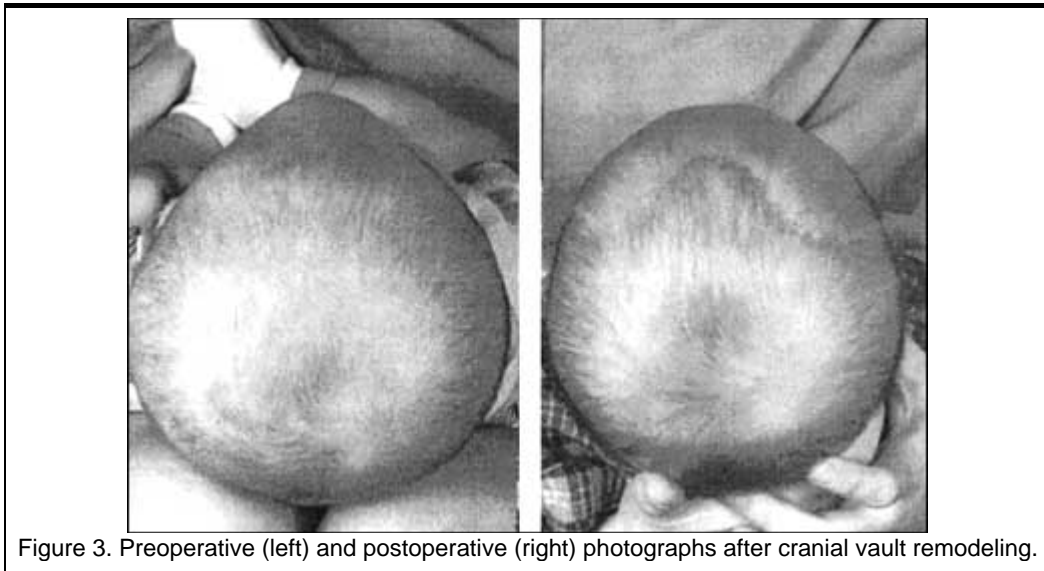


Figure 3. Preoperative (left) and postoperative (right) photographs after cranial vault remodeling.

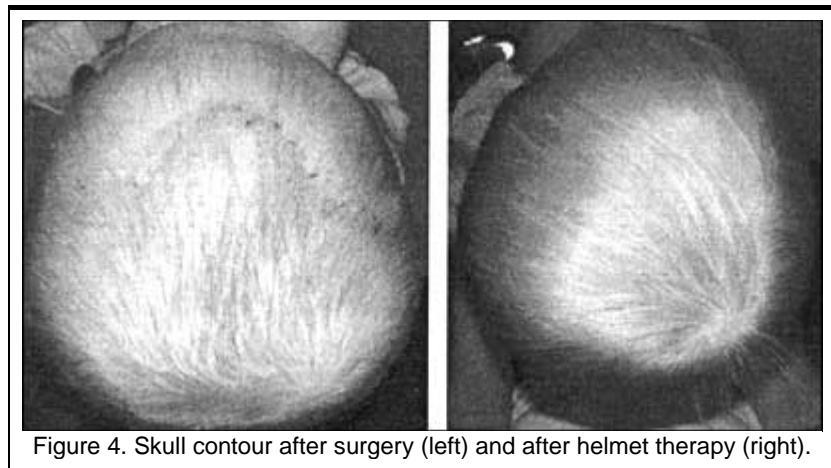


Figure 4. Skull contour after surgery (left) and after helmet therapy (right).

DISCUSSION

The efficacy of helmets in molding the immature cranial vault has been well established for the nonoperative treatment of nonsynostotic conditions.¹⁻³ However, the success is largely dependent on beginning treatment in the first year of life, while the brain is rapidly growing. This concept has been extended to postoperative patients undergoing minimal vault surgery, usually secondary to early operation for sagittal synostosis or using endoscopic assistance.^{4,5} This is because typically little is done intraoperatively to reshape the cranium in these operations. Little has been written about the use of helmets after aggressive cranial vault remodeling with frontal orbital advancement.

This series evaluates just such a group of patients. As with any major craniofacial operation involving multiple osteotomies, the end result is dependent upon many variables. Among these is the viability of the repositioned bone segments. Depending upon the surrounding vascular supply and the size of the bone fragment, there is variable resorption of these grafts. In addition, despite the best surgical efforts, asymmetries persist after cranial vault remodeling.

Intuitively, providing a template for the remodeled skull to grow into should improve the results by preventing undue pressure on the recently remodeled skull and allowing the rapidly growing brain to push forward the reconstructed segments symmetrically. Promising results with this technique have been documented as have data supporting the use of postoperative cranial orthoses after endoscopic-assisted strip craniectomies. A recent survey⁹ revealed that at least 12 centers in the United States are using postoperative cranial orthoses after cranial vault remodeling.

Another benefit of postoperative helmet therapy concerns the patient's family. Although the helmet is primarily constructed for molding and shaping of the skull, it can also provide the family with a "sense of security" regarding the recently remodeled skull fostering a positive and comfortable environment for the family and the patient during the postoperative course.

The results seen with this group of patients seem promising. Measurements taken after surgery and at the end of helmet treatment show remarkable improvement. All indices progress to the normative values in the patients evaluated. Unlike previous patients treated by our group, the asymmetries and irregularities were not seen with great frequency.

One of the most important issues to address in this evaluation is that of cost. Is this improvement in skull shape worth the added cost incurred by manufacturing of the helmet and regular visits to the orthotist and surgeon? To more thoroughly evaluate this, one would have to follow up patients treated with and without helmet molding and include the costs of secondary cranioplasty into the overall treatment cost. The average cost of postoperative helmet therapy is \$2,500 to \$4,000. This is substantially less than a second or subsequent cranial vault remodeling procedure, which can range up to \$36,131, including a hospital stay and anesthesia. As helmet therapy in the postoperative patient becomes more popular, these data should be forthcoming.

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