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Post-traumatic orbital floor reconstruction with nasoseptal cartilage in children

Mordechai Kraus [a], Albert Gatot [a], Daniel M. Kaplan [a], Dan M. Fliss [b,*]

[a] *Department of Otolaryngology, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
[b] *Faculty of Health Sciences, The Head and Neck Surgical Oncological Unit, Soroka University Medical Center, Ben-Gurion University of the Negev, Beer-Sheva, Israel*

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Abstract

Objective: Repair of orbital floor fractures may require the placement of a graft or implant. Both autogenous and alloplastic materials have been used for this purpose. This article reports the use of nasal septal cartilage for the repair of orbital floor defect secondary to blunt facial trauma in children. *Methods:* Three children with disruption of the orbital floor after facial trauma were included in this prospective review. All children underwent open reduction with rigid fixation of the facial fractures and reconstruction of the orbital floor with nasoseptal cartilage. *Results:* All of the cases were successfully treated by restoration of the orbital floor continuity. On follow-up clinical examination, one patient had persistent mild enophthalmus. *Conclusions:* Nasal septal cartilage is a readily accessible autogenous material with minimal donor site morbidity, and should be considered when an autogenous orbital implant is needed for the repair of a traumatic orbital floor defect.

1. Introduction

Facial fractures in the pediatric age group are uncommon. Only 5–15% of all maxillofacial injuries occur in children. Analysis of 1500 facial fractures revealed 5% of all fractures occurring in children younger than 12 years and less than 1% of fractures in children under 6 years of age [1,2].

The orbit, which is the boundary between the face and the cranium, exhibits different fracture patterns in children, which are dependent on the facial growth. In the classical blow out fracture of the inferior wall, segments of the orbital cavity are driven outward, resulting in a net increase in the intraorbital volume and downward displacement of periorbital tissue [3]. Blow out injuries were classified as pure fractures, consisting of an isolated outward displaced segment of the roof, floor, or walls, or impure fractures, where the orbital rim itself is disrupted. The treatment of these fractures requires accurate anatomic reduction and stable internal fixation in order to prevent malunion, contour deformities, herniation or entrapment of periorbital tissue [4,5]. For orbital floor fractures the surgeon has the option of using

* Corresponding author. Address: The Skull base Unit, Otolaryngology Department, Sorasky Medical Center, 6 Weitzman Street, Tel-Aviv, Israel. Tel.: +972-3-69735; fax: +972-3-6973553.

E-mail address: fliss@tasmc.health.gov.il (D.M. Fliss).

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either alloplastic or autogenous implants. The autogenous sites used in orbital surgery include the calvarial and iliac bone, split rib and cartilage. There are two main types of alloplastic materials: resorbable and nonresorbable. The resorbable include Gelfilm, polyglactin film, and a variety of homografts. The nonresorbable materials include Silastic sheets, Marlex mesh, Teflon, Prolene, polyethylene and metallic alloys [6–8].

Currently, the trend is to favor the use of autogenous grafts, mostly because of the AIDS epidemic [9]. The nasoseptal cartilage is a readily accessible autogenous material, which can be harvested with minimal donor site complications. It was believed for a long time that the nasal cartilage has an important role in the midface growth and development. There is a certain amount of doubt regarding the opinion that surgery of the nasal septum in children and in young people should be avoided [10]. This article reports the use of nasal septal cartilage for the repair of traumatic inferior orbital defect in three children.

2. Patients and materials

The clinical profile and outcome of three patients who underwent surgery for reduction of orbital floor fractures using septal cartilage is listed in Table 1. The three children in our study had pure blow out fracture of the inferior orbital floor. All patients had preoperative radiographic evaluation (craniofacial axial and coronal tomographic scans) and preoperative and postoperative otolaryngologic, maxillofacial and ophthalmologic evaluation. All the operations were performed by the same surgeons. The recorded preoperative clinical findings included diplopia, enophthalmus, infraorbital nerve paresthesia and limitation of ocular motility. Forced duction test was performed in all cases.

The criteria used for orbital surgery consisted of one or more of the following findings—extraocular muscle entrapment, large orbital defects (defined as more than 8 mm diameter or greater than 50% of the orbital floor) or orbital floor involvement with other midface fractures.

3. Surgical technique

The entrance incision to the nasoseptal cartilage was a hemitransfiction incision at the caudal rim of the septal cartilage. Once the mucopericondrium covering the septal cartilage is infiltrated with 1%-lidocaine with 1:100 000 epinephrine, a sharp dissection is carefully carried through the mucoperichondrium.

The mucoperichondrium is elevated from the most dorsal aspect of the septum to the maxillary crest bilaterally. A single part of the quadrilateral cartilage is harvested to cover the orbital floor defect. In order to prevent nasal collapse 1 cm of cartilage is left intact dorsally and caudally. The incision is closed with interrupted 4/0 Vicryl sutures and nasal packing is performed in the nasal cavities at the end of this procedure.

The orbit was approached through a transconjuctival approach without a lateral canthotomy. The transconjuctival incision was carried out with the lower lid everted and retracted away from the globe by a Desmarres retractor to the level of the inferior orbital rim. The periosteum overlying the orbital rim is incised and elevation of the periosteum and orbital floor exploration was accomplished in the routine fashion until the fracture is exposed. The size of the nasoseptal cartilage graft was estimated according

Table 1
Patients profiles undergoing surgery for orbital floor fracture

Patient No.	Age/Sex	Mechanism of injury	Follow up (months)	Complication
1	8/F	Motor vehicle accident	12	None
2	8/F	Fall	12	Enophthalmus
3	12/F	Assault	24	None

to the size of the orbital floor defect. Reduction of the orbital contents herniated into the maxillary sinus was performed and the septal cartilage was placed over the orbital floor in order to cover completely the margins of the defect. No fixation of the cartilage implant was used, but care was taken to ensure that the graft was well behind the inferior orbital margin. The conjunctival incision is closed with absorbable 6/0 Vicryl sutures. Forced duction test was performed at the end of the procedure to evaluate postoperative ocular motility. Enophthalmus was defined as a 2 mm or greater difference in distance from the apex of the cornea to the lateral canthus between both eyes. It was directly analyzed with the use of Hertl exophthalmometer. The success of the surgical repair and postoperative status have been tested at 1 week, 3 months, and 1 year for postoperative findings.

4. Results

In all patients a transconjuctival approach without lateral canthotomy for orbital floor exploration has been performed. The surgical repair of the orbital floor defect was done with nasoseptal cartilage. No complication related to submucous resection of the septal cartilage occurred. None of these children underwent revision surgery (Figs. 1 and 2). The postoperative complications included mild enophthalmus in one case. The mean length of follow up was 16 months.

5. Discussion

Maxillofacial fractures in the pediatric patient population account for 5–15% of all maxillofacial injuries. These results are based on the anatomical differences between the adult and pediatric craniofacial skeleton. The child's face is small in proportion to overall head size, with a flat midface and prominent frontal cranium. In addition, the more protected environment of children, and the use of car seat restrains for children, may contribute to the infrequent occurrence of pediatric maxillofacial fractures. The relative lack of pneumatization of the paranasal sinuses, which makes the pediatric

Fig. 1. Coronal view shows incarceration of right orbital soft tissue within a right orbital floor defect.

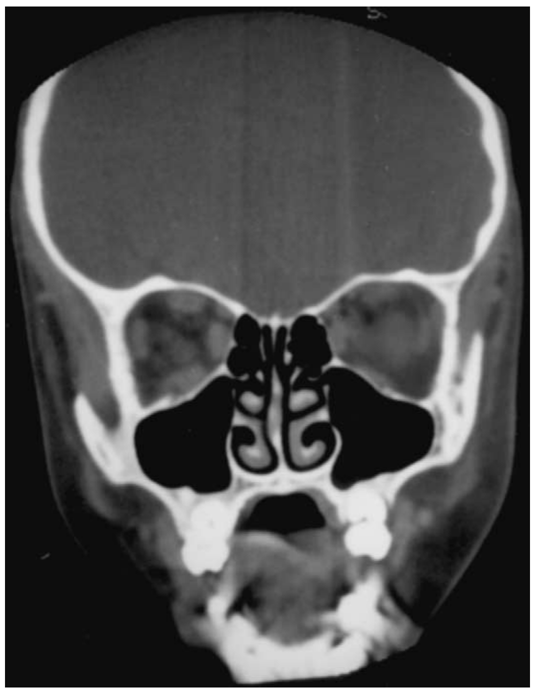

Fig. 2. Postoperative coronal computed tomographic scan shows resolution of the soft tissue incarceration and repaired orbital floor with septal cartilage.

facial skeleton more stable and elastic, and the expansion of these sinuses at the late adolescence is another factor which affect the changing pattern of orbital fracture in children [1,2].

Blow out fracture, a term given by Smith and Regan, describes orbital floor fracture resulting from a rapid increase in intraorbital pressure [11]. The blow out fracture has been classified by Converse and Smith as pure and impure fractures. The pure fracture are characterized by the presence of an isolated displaced fracture of the orbital roof, floor or walls. The impure fractures are distinguished by disruption and displacement of the circumferential bony rim of the orbit [4].

There is a different pattern of fracture between the orbital roof and the lower orbital fractures. Orbital roof fractures occur more frequently in younger children as a consequence of the large cranium proportionally to the smaller face and lack of frontal sinuses pneumatization. Lower orbital fractures, which involve the inferior wall occur primarily in older children as the result of increased vulnerability of the face due to its growth and pneumatization of the sinuses. This accounts for the observation that there is a significantly lower incidence of orbital blow out fractures in young children [12,13].

Early recognition of blow out fracture is critical. This will prevent undesirable atrophy of entrapmented orbital tissue into the maxillary sinus. High resolution CT scans are particularly useful in confirming the diagnosis. The incidence of associated ocular injury is significant and a detailed ophthalmologic assessment is indicated in each case [14].

Definitive repair of the orbital injury should be performed as soon as the general condition of the patient permits. The choice of implant in orbital reconstructive surgery has always been a source of controversy. A variety of implant materials have been used to recreate normal bony orbital dimension or supplement deficient orbital volume. These include alloplastic or autogenous material. The major advance has come in the use of alloplastic or autogenous implants for fixation and support of orbital contents in the anatomically correct position. The selection of implant in reconstruction of the orbit should be based on the advantages and disadvantages of each [15].

Three types of alloplastic implants are useful for orbital reconstruction: nonporous, porous and absorbable materials. The group of nonporous implants includes Silicone, Teflon and metallic implants. The absorbable implants, such as Gelfilm may be useful in small orbital wall defects.

Hydroxyapatite and porous polyethylene are the two most popular porous implants. The most important advantage of these implants is the ability of fibromuscular ingrowth into the alloplast which offers better positional stabilization and fixation of the implant to the bony orbit and resistance to infection once it is vascularized. However the alloplastic materials can cause complications such as extrusion, migration, and infection of the implants and dental or maxillary sinus infection [16,17]. Autogenous tissues have been used since the beginning of the century. Proponents of autogenous grafts focus on the high risk of infection with alloplastic materials. Autogenous grafts avoid this complication, but have their own problems. The three major problems are additional operative time, donor site morbidity and graft resorption. Despite these problems autogenous grafts have greater biocompatibility and minimal morbidity when compared to alloplastic materials [15,17].

Four autogenous donor sites are commonly used in orbital surgery: cranial and iliac bone, split rib and cartilage. Cartilage can be harvested from ribs, ears and septum. The nasoseptal cartilage is an autogenous source that provides support to the orbital floor, can be harvested with no significant increased operative time and minimal donor site complications. In our study, no complication was observed during the follow up period. To the best of our knowledge, this is the first reported series of pediatric patients using the nasoseptal cartilage for the orbital floor fracture repair [18]. The role of septal cartilage in the growth and development of the face has long been a concern of clinicians. For this reason septal surgery in children has been considered potentially problematic for a long time. Animal studies by Hartshorn, Sarnat and Wexler, in which total cartilaginous septectomy including the overlying mucoperichondrium was performed showed post-operative retardation of growth in the midface area [19–21]. Fuchs also found in his animal study underdevelopment of the nasal bones after removal of the mucoperichondrium from selected areas over the septal cartilage. In addition partial destruction of cartilage with some evidence of regeneration, some osteogenesis and newly formed capillaries in the cartilage was seen microscopically [22]. Bernstein repeated procedures on canine pups and cats by performing complete resection of the septal cartilage with preservation of the mucoperichondrium and showed no discernible growth diminishing effect. In this study, implanted septal cartilaginous autografts were shown to continue to grow. It is believed that mucoperichondrium on either side of the cartilage, which remains in vivo, plays a critical role in septal growth and consequently in nasal growth [23]. Meeuwis used growing rabbits as an experimental model and found that partial resection of the basal rim of the septal cartilage had no effect on the nasal growth of the nasal dorsum. The dorsum supporting zone is thought to be responsible for the increase of the bony nasal dorsum [24,25]. In our study the removal of a partial septal cartilage segment was performed. This segment did not include the attached mucoperichondrium.

Although conclusion drawn from experiments in animals are not necessarily valid in humans, it seems reasonable to presume that some principles of growth and development may be common [23].

We used the transconjunctival approach in the three cases of these series. The transconjunctival approach, when compared to the subciliary approach, has better esthetic results with lower incidence of ectropion. The access to the orbital floor was satisfactory in our cases without using a lateral canthotomy [26].

In conclusion, the nasal septal cartilage is a readily accessible and durable material, which can be used safely for reconstruction of inferior orbital wall defects in children.

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