Case Report

ORBITAL FLOOR FRACTURE REPAIR BY CALVARIAL GRAFT FOR AN 18-MONTH-OLD BABY USING PIEZOSURGERY

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ABSTRACT

Pediatric orbital floor fractures are uncommon, especially in babies under the age of 2 years old. The conservative treatment is usually used except in inferior rectus entrapment, enopthalmous, and diplopia cases. Autogenous bone is an attractive option in a growing skeleton, but donor site immaturity presents a challenge for the surgeon. Although cranial grafts are a great option in adults, the lack of diploic space maturity separating the outer and inner tables might be discouraging. The use of prosthetic material might result in migration with growth and typically will require removal in a second surgery. Resorbable implants are attractive but can be expensive and might not be available in all trauma centers. In this research, we report a case of orbital floor fracture in an 18-month-old baby who presented with worsening enophthalmos repaired by calvarial graft using the piezosurgery and three-dimensional printed skull model after mirror imaging the non-affected side.

Key words: Orbital fracture, Pediatric fracture, Calvarial graft, Enophthalmos, Piezosurgery.

Introduction

Pediatric orbital fractures are uncommon when compared to adults and other orthopedic fractures. Facial fractures in patients less than 18 years old represent 14.7% of all facial fractures, but only 5.6% of this group was under the age of 5 years [1]. This may be explained by different protective mechanisms in the pediatric population, including the calvarium's prominence, bony sutures' flexibility, thicker fat layer, juvenile bone elasticity, presence of teeth buds, and late pneumatization of the paranasal sinuses [2, 3]. The most common facial fractures in children include nasal and dento-alveolar fractures [4]. The mechanism of injury commonly involves falls, motor vehicle accidents, sports, and less likely altercations [5].

Orbital fracture management in the adult population remains controversial in timing, indications, and implanted material selection [6]. Indications for the repair of orbital floor fracture include entrapment of the inferior rectus muscle, enophthalmos, and binocular diplopia. Pediatric orbital fractures are considered rare and lack consensus and guidelines for their management. Inferior rectus muscle entrapment might occur in a bony trapdoor type of fracture of the orbital floor. This may present with occulo-cardiac reflex symptoms such as bradycardia and hypotension. It requires urgent surgical intervention [7].

Orbital blow-out fracture increases the orbital volume and subsequently may result in the development of enophthalmos. A thorough ophthalmologic examination is mandatory to rule out any intraocular damage. Delaying treatment for a week or two is commonly done to properly assess the globe position after the resolution of the edema. The globe position results from the complex relationship between orbital bone volume and periorbital soft tissues. Enopthalmous might develop weeks after the injury. Assessing the size of the floor defect might help in predicting the development of such a complication [8].

Case report

An 18-month-old baby presented for evaluation after pulling a heavy decorative object off the table, which fell on his face. The patient did not lose consciousness and did not vomit. His parents denied any other medical problems. A computed tomography scan was obtained at the emergency room at King Abdulaziz University Hospital **(Figure 1)**, which revealed an orbital blow-out fracture involving about 50% of the right orbital floor.

a)

b)

Figure 1. CT scan (a) coronal cut, b) Sagittal cut) showing depressed orbital blow-out fracture

Initial clinical exam showed right subconjunctival hemorrhage, periorbital edema, and ecchymosis. There was no restriction in the movement of the extraocular muscles. However, Ophthalmologic evaluation revealed intact pupillary reflexes and no intraocular injuries. It was difficult to assess for diplopia, given his age. After one week, the swelling resolved for the most part, and he developed a subtle right enophthalmos. The distance from the lateral orbital rim to the corneal apex was measured using a Hertel exopthalmometer. There was a 3-millimeter difference between the right and left eyes. Four weeks later, the enophthalmos became more clinically evident, and the difference increased to 4 millimeters **(Figure 2)**.

Figure 2. Right enopthalmous of 4 mm is visible clinically in bird's eye view 4 weeks after the trauma

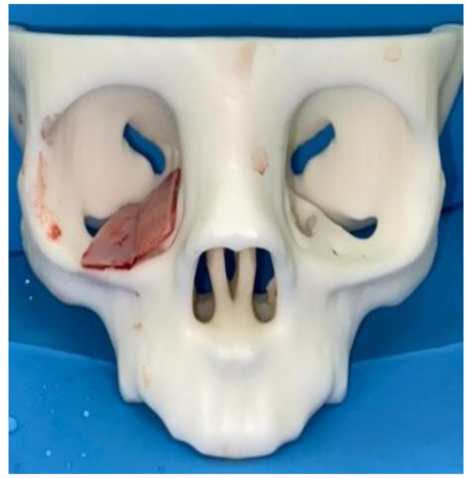


Figure 3. Three-dimensional mirror-imaged model of the patient with cranial block grafts shaped to cover the defect

A three-dimensional model with mirror imaging of the left side was printed to facilitate shaping the graft **(Figure 3)**. The surgery was done under general anesthesia with orotracheal intubation in a supine position. CT scan of the skull showed a lack of diploic space. The bone graft block was planned 2 cm away from the midsagittal plane to avoid the sagittal sinus. Piezosurgery was used to mark the borders of the cranial graft from the left parietal bone using a 4-centimeter incision. One of the borders was beveled to facilitate the use of curved osteotomes to finish the harvest. The outer table was successfully harvested despite the lack of radiographic diploe. After harvesting the block, there was a 2 mm area of exposed intact dura, and a neurosurgeon was consulted. He recommended no coverage of the defect. The graft was shaped on the 3d model and placed using a transconjunctival retro-septal approach. Slight over-correction was planned to account for bone graft resorption and periorbital soft tissue atrophy. A forced duction test was conducted after graft placement to ensure that there was no muscle entrapment. Post-operative CT scan showed good reconstruction of the orbital floor **(Figure 4)**.

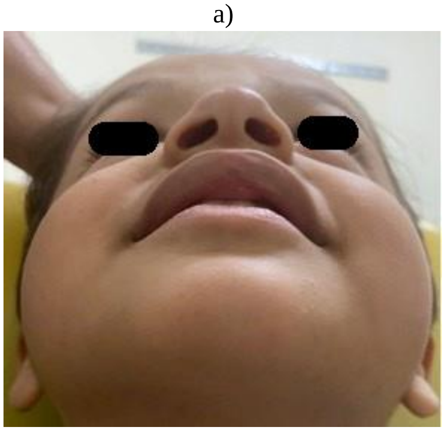
a)

b)

Figure 4. Post-operative CT Scan (a) coronal cut, b) Sagittal cut) showing good reconstruction of the orbital floor

The post-operative course was uncomplicated, with a resolution of the enophthalmos. The patient was seen at a 2-year follow-up with normal growth and no complications **(Figure 5)**.

a)



b)

Figure 5. 2 year-follow up after the surgery showing normal growth and symmetry. (a) bird's eye view, b) worm's eye view)

Results and Discussion

Facial fractures represent a small percentage of orthopedic injuries in pediatric patients, especially those under the age of 5 years [1]. This may be attributed to anatomic protective factors such as bone elasticity, thicker fat layer, and the presence of flexible bony sutures. Orbital fracture management in adults remains controversial in timing, an indication of surgical repair, surgical approaches, and materials used. Pediatric fractures are less common and lack clear guidelines, which requires a tailored approach to management.

Clear indications of surgical repair of orbital floor fractures include muscle entrapment, binocular diplopia, and enophthalmos. Trapdoor fractures are common in the pediatric population and require immediate intervention and careful examination [7]. The risk of delayed enophthalmos is where controversy exists.

Radiographic assessment of the size of the defect has been studied as a guide to predict the risk of late enophthalmos. Frohwitter *et al*. recommended critical size defects of more than 2 Cm^2 on computed tomography (CT scan) [8]. Wevers *et al*. conducted a systematic review to evaluate CT parameters used in the decision-making of borderline orbital floor fractures [9]. They recommended considering the multiple parameters simultaneously in the decision-making. These include fracture size and location, orbital volume, soft tissue involvement, and craniocaudal dimension. The role of periorbital tissue in late enophthalmos was reported in multiple studies [10, 11].

The size of the defect in the reported patient was about 2 $Cm^{2,}$ but it represented a high percentage (about 50%) of his orbital floor. Conservative management was considered initially, but surgery was done due to the worsening enophthalmos. Moreover, It was difficult to establish the presence of diplopia. It is well known that secondary correction of enophthalmos is more challenging than primary repair.

Using a prosthetic material might result in migration with growth or will necessitate removal in a secondary surgery [12]. Resorbable materials are a valid option but are expensive and might not be available in stock for timely use [13]. Titanium mesh is used routinely in adults but would require a second surgery for removal in a growing skeleton. Autogenous bone graft is commonly used in adults, but donor site maturity might present a challenge for a safe harvest in pediatric patients. Autogenous graft has a lower risk of infection and material extrusion compared to prosthetic implants. This can be obtained from the skull, iliac bone, mandible symphysis, and ribs [14].

Bone graft from the outer table of the calvarium has been effectively used in adults with great outcomes [15]. It has many advantages, including matching the orbital floor curvature, less resorption compared to iliac grafts and a hidden scar. The presence of diploe space between the outer and inner table facilitates harvesting the outer table without dural injury; however, diploic space was not seen consistently in the first 2 years of life on radiographic review of pediatric computed tomography [16]. It was absent in the reported patient's CT scan. The use of piezosurgery allowed for the safe harvesting of the graft. Small full-thickness defect with intact dura heals uneventfully in this age group. If a complete bicortical harvest had occurred, the plan was to split the graft in half to cover the defect. The use of a 3D skull model facilitated the shaping of the graft. Slight overcorrection was done to account for bone resorption and possible periorbital tissue atrophy.

Conclusion

The calvarial graft can be harvested and used safely in the pediatric population by utilizing piezosurgery to repair indicated orbital floor fractures. The indication, timing, and technique for managing pediatric orbital floor fractures remain controversial. A patient-specific treatment plan must be based on multiple clinical and radiographic factors to assess the risk of late enophthalmos.

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