Case Report - Trauma

# Blowout fracture-orbital floor reconstruction using costochondral cartilage causing pain, warping, and diplopia

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## ABSTRACT

Orbital floor reconstruction is the most challenging component in the midfacial trauma management. Most often owing to the complexity of the fractures, the floor reconstruction requires grafts or other substitutes. Literature reveals several sources of autogenous sources of such grafts. Though most of the grafts are well taken and gives an ideal result, at certain instances, owing to the complex nature of the graft, its biochemical nature, reaction to the grafting, biochemical response, a reactionary change may result at late stages. The aim of this manuscript is to present a rare instance of warping of a costochondral graft that was used as a part of the orbital floor reconstruction giving rise to an ophthalmic emergency. The situation was immediately diagnosed and successfully managed. The situation, structural, and biochemical mechanisms behind such a phenomenon are discussed.

**Keywords:** Cartilage warping, diplopia, orbital floor reconstruction

## INTRODUCTION

Road traffic accident (RTA)-related fractures of the mid-face often involve the bony parts of the orbit. Depending on the direction and velocity of trauma, varying types of orbital fractures could occur. The orbital floor fracture is one of the most common clinical situations, especially occurring in conjunction with the zygomatic "tripod fracture."[1] In such situation, especially with severely comminuted fractures, additional grafts are required during reconstruction. There are several types of grafts suggested for the orbital floor reconstruction.[2] A recent systematic review has suggested that autologous bone still remains as the most reliable and predictable type of graft.[2] The autologous bone graft for orbital reconstruction could be procured from calvarium, jaw bones, iliac crest, and ribs. In times of head injury, procuring grafts from calvarium or jaw bones may be difficult. At times, the patients' or their attenders' choice would be against such a donor site. This often leaves behind iliac crest and costochondral graft (CCG) as the only choice of bone graft.

Iliac grafts may have donor site risk of peritonitis, pain, difficulty in ambulating, and sensation loss. CCGs, if not properly performed, have an inherent risk of pleural perforation and rarely mediastinitis.[3] In addition, iliac and rib bones are of endochondral origin which predisposes them to accelerated resorption rates as compared with membranous bone grafts.[3,4] Hence, such grafts have to be procured and used with extreme care. In addition, use of such grafts enmeshed in titanium has been claimed to reduce the rate of resorption.[3]



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Warping is a known phenomenon to affect the CCG owing to their formation, curved nature, and biochemical makeup. Such event can be used in favor or at times would create an issue with final results, especially in critical areas such as the dorsal augmentation rhinoplasty.[5]

Till date, there has been no report of warping complicating an orbital floor repair. The intent of this case report is to describe a case, wherein warping has caused unexpected compression of orbital contents and to the best of our knowledge, we have not come across such complications in the postoperative period after orbital floor reconstruction.

## CASE REPORT

A 29-year-old male reported for a correction of fracture after an RTA. History revealed that the patient had an RTA 10 days back with multiple injuries on the face and was hospitalized. On pursuing the records, it was observed that in the immediate trauma period, he had been identified with right circumorbital ecchymosis, subconjunctival hemorrhage, step deformity in infraorbital rim, zygomatic buttress depression, and enophthalmos [Figure 1a-c]. Furthermore, the patient reported of haziness in vision in the right eye; diplopia was noted. He was identified with orbital bone fractures including the zygomatic tripod. Owing to the direct blow in the RTA to the zygoma, there were fractures of the zygomatic arch, lateral orbital wall, and inferior orbital floor. Imaging studies confirmed the same and noted marginal lateral rectus entrapment with the fractures. Timing of surgery merely depends on the clinical and radiographic features.

He underwent fracture reduction of the right zygomatic complex fracture involving the floor of the orbit, infra- and supra-orbital rim. There are various approaches to repair the floor of the orbits; here, we have used transconjunctival incision for adequate exposure and efficient repair. Under general anesthesia, open reduction and internal fixation were performed [Figure 2a and b]. The inferior orbital floor was reconstructed with CCG encased in a titanium mesh which was fixed with titanium plates and screws. Apart from the approaches and surgical timing, material for the management of the fracture has a prime role. Surgeon's choice of material should be of minimal complications providing good results.

After the operation, he had been prescribed wide spectrum antibiotics; nonsteroidal anti-inflammatory drugs (NSAIDs); serratiopeptidase, and tobramycin ointment to be applied over the eye.

After the operation, his hemorrhage, haziness in vision, and diplopia ceased restoring normal vision. All movements of the eyeball were normal for about 4 weeks [Figure 3a and b]. Postoperatively after a month, he was experiencing an acute, continuous, increasingly severe pain in the right eye for which he sought consultation again.

On observation, all findings were confirmed. His vision was near normal and clinically exhibited normal eyeball movements with strain. No clinical abnormalities, barring a slight slant of the involved orbit en mass displacement were detectable. No visible enophthalmos or exophthalmos was seen. Imaging studies were repeated to study the internal anatomy of the orbit.

On the same, it was evident from magnetic resonance imaging that the graft was abnormally twisted, showing features of warping [Figure 4a and b]. The change of dimensions as a result of warping compressed the orbital content. A diagnosis of developing orbital compression syndrome was observed. Under general anesthesia and standard preparation, on an emergency basis, using the transconjunctival incision, the graft forming the floor of the orbit was removed and the floor was reconstructed with titanium mesh alone [Figure 5a and b].

The exonerated graft surface was intact, but exhibited a severe dimensional change [Figure 5c]. Incision was closed and appropriate antibiotics; NSAIDs were given. The patient was observed periodically and recuperated well with no complication. After 4 weeks, all eye movements returned to normal along with a straight normal gaze [Figure 6a and b].

## DISCUSSION

Autologous bone grafts, from any source, still remains the "gold standard" for orbital floor reconstruction. They provide the much needed rigidity, vascularity, biocompatibility, and no or less minimal immune reactivity. They have a longer half-life period. Enmeshing the grafts, especially those bones from endochondral in origin, is said to retard the rate of resorption.[1-4]

Restoring orbital volume, particularly after "blow-out" fractures is crucial. The timing of the surgery and the healing of the periorbital musculature, especially if there is an entrapment, are other additional factors would affect the outcome of the function of the musculatures.[6] Though orbital hematoma is a major factor that causes an ophthalmic emergency, in rare instances, orbital compression syndrome may occur by physical compression of the orbital contents.[7] In the present case, after the initial reconstruction, the patient was recovering well and when the graft started to warp, the orbital volume started to reduce. This exerted a pressure on the orbital content. On exertion of pressure, the orbital volume is squeezed to cause exophthalmos. Probably, the preexisting, residual, periorbital inflammation has masked the same.

The decreasing orbital volume has created an increasing pressure intraorbitally that was perceived by the patient as pain which correlated in being continuous, slowly increasing in severity (probably related to the degree of warping), and persistent. As the orbital pressure is relieved by the removal of the bone and restored with titanium mesh, the patient responded well to intervention.

Warping is a known phenomenon and has been widely studied.[5,8] In the rib, as a CCG for rhinoplasty, it has been shown that systematic, concentric carving from the center of rib segments would reduce the incidence of warping.[8] The inherent tissue forces of warping appear to exert its influence more in the dorsoventral dimension than in other dimensions

**Figure 1:** (a and b) Preoperative frontal and worms eye view. (c) 3DCT showing communited fracture of the orbital walls and zygoma

**Figure 3:** (a and b) Stage 1 postoperative view showing globe displacement

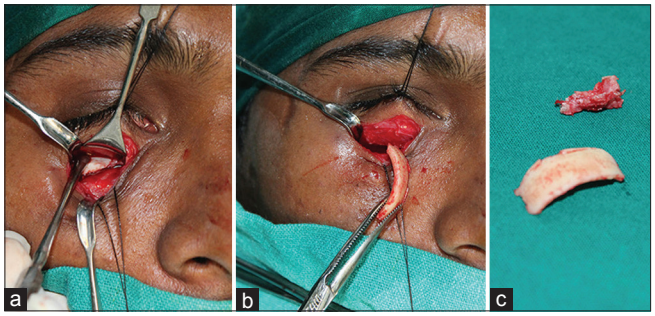

**Figure 5:** (a) Picture showing warped cartilage. (b) Exonerated costochondral graft. (c) Figure depicting degree of warped cartilage

while side-to-side warping often goes unnoticed.[8] The absence of tension-relieving mechanisms in the graft used in this case probably has contributed to the same. The end time of warping of CCG is still debated, and there is no proposal for the same.[8]

Mineralized cartilage, such as rib, is known to have high calcium content than the adjacent bone. This sudden change would be seen as a difference of calcium particle orientation at the interface between the bone and cartilage. The calcium-rich particles of rib were aligned perpendicular to the interface in cartilage, whereas in bone, they are oriented parallel.[9] The intense carving and shaping would have given rise to internal stress that probably has relieved and manifested as dimensional changes days after the surgery. Another possibility is the biochemical makeup of the CCG. The CCG graft is known to have three major phases: A solid matrix, interstitial water, and mobile ions (mainly sodium and chloride) within the tissue. The composition and structure

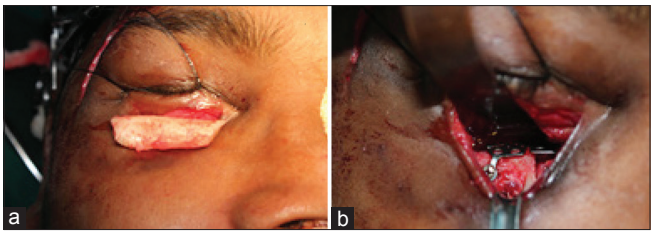

**Figure 2:** (a) CC graft used in orbital floor reconstruction. (b) Titanium plates are used in fixation of CC graft

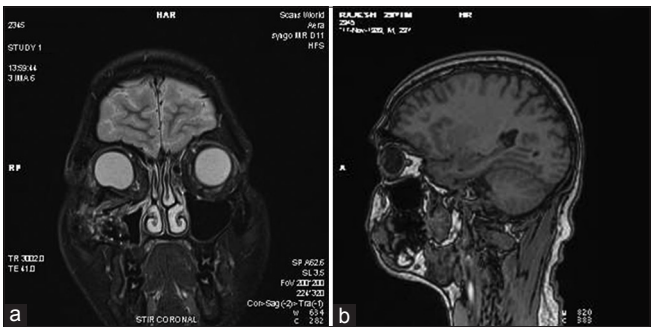

**Figure 4:** (a and b) MRI scan image showing warping of the graft and subsequent compression of orbital contents

**Figure 6:** (a and b) Stage II postoperative lateral view and worms eye view showing globe in plane

of these phases differ with the type of cartilage and with depth. Collagen, water, and proteoglycan content, as well as the orientation of collagen fiber, vary within these three phases. This, in turn, influences the material properties of the tissue. After any grafting, there would be a change in the composition of surrounding tissue fluids creating an imbalance of the ion concentration between inside and outside of the tissue. This imbalance leads to the rise of osmotic pressure and an associated propensity to swell leading to dimension changes.[10,11] Other than these, the influence of inflammatory mediators has to be considered.

In spite of the biological mechanism behind warping, a careful approach needs to be exercised while using complex grafts such as CCG. The nature of the graft, its position, and possible tissue graft interaction has to be considered. In addition, there are several ways by which a graft should be modified to accommodate the warping.[12] Such modification, when incorporated, would account for dimensional changes and thereby efficiently preventing untoward events.

## CONCLUSION

This case report is probably the first instance to report a potential ophthalmic emergency due to the use of the CCG for orbital reconstruction due to warping. Continuous follow-up and periodical checkup would be necessary in the case of orbital floor reconstruction, particularly if a CCG is used. The phenomenon of warping is to be expected and every sincere effort to counteract the same needs to be installed.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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