



Differential Volumetric Orbital Restoration (DVOR) for Correction of Traumatic Ocular Malposition

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Abstract

Background: Severe orbital fractures may lead to ocular malposition in the form of enophthalmos or dystopia not only due to loss of ocular support provided by the orbital floor or incarceration of the extra-ocular muscles but also due to interference with the delicate balance between the volume of the intra orbital contents and the total orbital volume. This occurs due to either increase of the total orbital volume induced by fracture or displacement of the conal fat through fascial ligament lacerations intraorbitally or extraorbitally. Restoration of the intra-orbital volume is mandatory to prevent and treat these cases, however the volume and location of this restored volume has to be accurately calculated to optimize the result. Inadequate management of orbital fractures leads to periocular fibrosis which plays a detrimental effect in operative restoration of the ocular position in the orbit.

Patients and Methods: Twelve patients have been treated for ocular malposition after trauma, 10 patients were treated acutely within 4 weeks after trauma and 2 patients were treated after longstanding ocular malposition (6 months and 26 months after trauma). Three-dimensional CT scan and occasionally orbital volumetry (5 cases) were done, restoration of the orbital skeleton with mini-plates, and screws was achieved, and reconstruction of the orbital floor was done by titanium mesh in acute patients. Ocular position is determined and then the volume and exact location of the volume spacer was evaluated by introducing a Foley's catheter and inflating its balloon until a proper ocular position restoration is achieved clinically which was followed by placement of a measurable dermo fat graft in the proper site.

Results: There was immediate improvement postoperatively (normal ocular position) in all acute patients, one patient had postoperative diplopia without enophthalmos, which had resolved 2 weeks later, another patient had moderate enophthalmos 3 months later with diplopia in the upward gaze and the patient was followed up and his diplopia improved. while in chronic cases we had full improvement in one case (6 months after trauma) and 50% improvement in the other case (26 months after trauma) with stable results after one week and 3 months, the first patient had no diplopia preoperatively or postoperatively, the second patient had diplopia in upward gaze which improved partially after surgery.

Conclusion: Differential Volumetric Orbital Restoration (DVOR) is a helpful tool to correct ocular malposition after severe orbital trauma as it refines the volume and the location of the orbital spacer to achieve accurate restoration of ocular position.

Keywords: Enophthalmos; Orbital fracture; Diplopia; Dystopia; Orbital volume

Introduction

Surgical correction of post-traumatic enophthalmos and dystopia remains one of the great challenges for the maxillofacial team owing to technical dangers, namely, injury to eye globe, optic nerve, and surrounding structures. Enophthalmos may not appear readily following trauma due to periorbital swelling in orbital fractures, the surgeon will always try to predict the extent of post-operative enophthalmos and tailor the orbital reconstruction accordingly. Pre-operative orbital volumetric studies are useful in predicting the outcomes of such reconstructive surgeries using Computed Tomography (CT) (Figure 1). Causes of enophthalmos are numerous, and several of

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Figure 1: Pre-operative CT scan coronal view showing orbital floor disruption.



Figure 2 and 3: Pre-operative (left) and postoperative (right) worm's view of a left Zygomaticomaxillary complex fracture accompanied with orbital fractures, note enophthalmos and dystopia of left eye and improvement in the postoperative photo.



Figure 4 and 5: Pre-operative (left) and postoperative (right) front view of same patient with improvement of enophthalmos and dystopia.

the following factors may contribute to post-operative deformity; orbital volume enlargement by displaced fractures, orbital fat atrophy or necrosis, loss of fascial ligament integrity, and entrapment of connective tissue in blowout fractures [1].

Until recently, it was assumed that correction of orbital skeletal architecture surgically, was sufficient to restore orbital volume and shape to the pre-traumatic status. Yet, other factors may cause suboptimal late postoperative outcomes, such as alterations in volume and position of soft tissues and the shape of the internal orbit [2,3]. There is evidence for a correlation between the position of the eye globe, the site of the fracture and the early increase in volume of the orbit following dislocation of the bony components [2]. Thus, the reduction of outward dislocation of the soft tissues and correction of the volume of the orbit are considered the aims of treatment.

It must be remembered that an orbital floor defect alone will

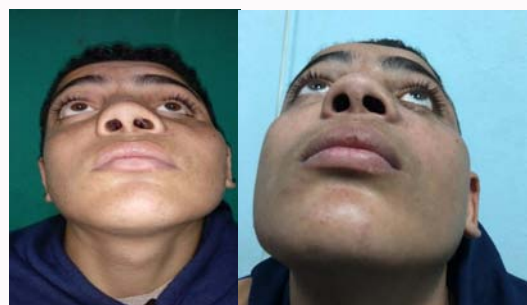


Figure 6 and 7: Preoperative (left) worm's view of patient after 6 months' trauma showing enophthalmos of the left eye and postoperative view (right) showing successful restoration of normal eye position.



Figure 8: (A & B) Foley's catheter introduced through an infra orbital incision to determine volume and orientation of dermo-fat graft(left) and the orbital rim perimeter marked like clock face (orbital clock) (right).

not necessarily cause enophthalmos if the integrity of the fascial sling supporting the eye is intact, as discussed by Gilbard et al. [4], and Rowe-Jones et al. [5] damage to the ligamentous sling may be witnessed as enlarged and rounded inferior rectus on CT.

In cases of severe orbital fractures, which is usually accompanied by loss of fascial sling support, incarceration of the extra-ocular muscles, along with loss of orbital fat, surgery shouldn't be solely aimed to achieve correct bone healing but rather reconstitute the defect both anatomically and functionally [6].

Autologous fat grafting or lipo-augmentation has been used to correct a variety of facial volume-related deformities, including trauma, aging, cancer, and other disease processes. Fat is easily harvested with minimal donor-site morbidity. Autologous fat may be good filler for post-traumatic enophthalmos because of its ease of placement, versatility in adjusting various defects, and biocompatibility [7].

Patients and Methods

The study includes twelve patients suffering from ocular malposition due to unilateral orbital fractures who presented to our team service in three hospitals (As-Salam hospital, Menoufia University hospital and Maadi plastic surgery center). Ten patients were treated acutely within 4 weeks after trauma and Figures 2-5 and two patients were treated after a longstanding orbital fractures (6 months and 26-month post-trauma) (Figure 6 and 7).

Three-dimensional CT scans and occasionally orbital volumetric studies (3 cases) were done. The frontal views are important to confirm orbital floor, lateral and medial wall fractures, and detect any incarceration also it gives a good idea about the anteroposterior level of the fracture.

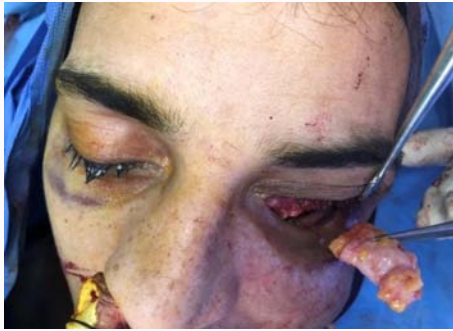


Figure 9: Dermo-fat graft before introduction underneath the eye globe.

Surgical technique

1. Access to the orbit was done through infra-orbital incision after injection of diluted adrenaline 1 in 200,000 and local anesthetic (xylocaine), dissection was done through the orbicularis oculi muscle until the arcus marginalis was seen where the periosteum is incised, this is followed by sub-periosteal dissection of the orbital contents taking care of hemostasis by bipolar diathermy especially of the vascular branch coming from the infra orbital vessels traversing the orbital space to the periorbital.

2. Orbital skeleton was restored after accurate reduction and fixation by means of titanium mini-plates and mini-screws (1.5 mm) and orbital floor reconstruction by means of titanium mesh in all acute patients.

3. Differential Volumetric Orbital Restoration (DVOR) was done in two steps the first (step A) was done by replacement of the prolapsed orbital fat through the disrupted suspensory fascial ligament to its normal compartment and repair of the ligament was done by 7/0 prolene sutures. This corrects the enophthalmos in some cases. If the prolapsed fat was atrophic or necrotic especially with neglected cases, then we proceed with the second step (step B) by introduction of a 12 F Foley's catheter (after trimming of the anterior part in front of the balloon) at different sites of the orbital perimeter and injection of measurable volume of saline was done testing the ocular improvement from above and below (bird's and worm's views) comparing it with the normal side and recording the site at the orbital perimeter (orbital clock) (e.g. 7 O'clock), the depth (e.g. 3.5 cm) and the volume (e.g. 10 cc). Then dermo-fat graft was obtained from the lower abdomen and rolled in as cylinder by 4/0 vicryl sutures and cut to match the volume needed and inserted in the assigned position. Ocular position was compared to the unaffected eye from birds view and worm's view as well as the level of both pupils (Figures 8-10).

The patients were divided into three groups according to the time and type of operative intervention:

First group (7 cases): These groups presented early after trauma and operative intervention was done during the first week, orbital bony restoration was done by reduction and internal fixation and then Differential Volumetric Orbital Restoration (DVOR) was done by (step A) only. This corrects the enophthalmic eye clinically in all the cases.

Second group (3 cases): These groups presented after 2 weeks after trauma, bony orbital restoration was done as before, while correction of the enophthalmic (2 cases) and dystopic eyes (one case) could not be achieved by DVOR (step A) only and we had to go through to (step B).



Figure 10: Pre-operative (top) and immediate post-operative (bottom) views showing improvement of the deepening of the supra-tarsal crease after DVOR.

Third group (2 cases): These are patients who presented very late (6 and 26 months) complaining of enophthalmos after orbital trauma, these patients had their orbital bony restoration done elsewhere after trauma, so correction of enophthalmos was done by DVOR (step B) from the start through infra orbital incision after exploration of the orbit inferiorly, laterally and medially and release of incarceration of the ocular musculature and fat through small unrepaired orbital floor defects. Marked fibrosis in the periorbital tissues was released very carefully by circumferential release incisions to allow advancement of the eye anteriorly. Then the dermo-fat graft was inserted as before.

Follow up CT scans was done after 3 days and after 3 months.

Results

The patients were assessed immediately after surgery, one week and 3 months later for stability of the results as well as CT scan one week after surgery.

In the first group (7 patients): we had immediate improvement postoperatively (normal ocular position) in all patients, one patient had diplopia without enophthalmos postoperatively which had improved 2 weeks later. We had no patients with persistent enophthalmos in this group.

In the second group (3 patients): we had immediate improvement (normal ocular position) in all patients, and moderate enophthalmos 3 months later in one patients with diplopia in the upward gaze and the patient was followed up and his diplopia improved and he did not agree to have another surgery, he said it is not affecting his life or job.

In the third group (2 patients): we had full improvement in one case (6 months after trauma) and 50% improvement in the other case (26 months after trauma) with stable results after one week and 3 months, both patients had no diplopia preoperatively or postoperatively despite the presence of enophthalmos.

CT scan with soft tissue window indicated volume and positional stability of the dermo-fat graft and repair of the fascial ligaments.

Discussion

The eye globe volume is 7 cc, while the orbital volume is 30 cc, so this means that it is not just spanning the orbit but it is suspended inside it, three mechanisms control this accurate position; the intact bony framework, the ligamentous structures suspending the globe

(through its attachment to the bony framework) and the volumetric balance between the eye globe (with its periorbital tissues) and the orbit. In severe orbital fracture, ocular malposition occurs due to loss of integrity of one or more of the above three mechanisms. So it is not questionable why some patients with perfect orbital bony restoration still have ocular malposition mainly enophthalmos and less commonly dystopia. Nevertheless, perfect bony restoration is the primary goal before proceeding to other maneuvers [1,2,8]. The orbital fascial suspensory ligament of lock wood carries the globe like a hammock and stretches between the medial and lateral check ligaments and encloses the inferior rectus and inferior oblique muscles. Another important role is that it keeps the conal fat inside the retro-ocular space preventing it from escape to the wide orbital cavity and playing a very important role in prevention of enophthalmos. Restoration of its integrity is important step in prevention of enophthalmos. Many authors have emphasized on the role of the intra-orbital volume as an important factor in production of normal eye position [1-3,8-11].

There pair of this ligament after replacing the prolapsed fat to its conal place to prevent enophthalmos has improved our results so much in the last ten years. If the ligament is severely disrupted and lacerated beyond repair, or the prolapsed conal fat has degenerated and lost its volume from traumatic necrosis then orbital volume replacement is needed by an extrinsic tissues and we used the dermo-fat graft obtained from the lower abdomen with measurable volume and site as indicated before by using a Foley's catheter determination. So by this stepladder technique a comprehensive treatment of ocular malposition is guaranteed. We think this is more durable and consistent than fluid fat injection which can dissolve or escape anywhere in the orbit. Dermo-fat is more consistent in facial augmentation in the hands of plastic surgeons than fat graft [7,12]. Generally, we have found out that this volume replacement is needed more medially than laterally (at 7 to 9 O'clock position) and more posterior (more than 3.5 cm from orbital rim) to treat enophthalmos. While dystopia was treated by the more anterior position of the volume replacement. But because it was very common to have dystopia accompanied by enophthalmos the volume replacement was generally extending from back to more anterior than enophthalmos alone.

Conclusion

Differential Volumetric Orbital Restoration (DVOR) is a helpful tool to correct ocular malposition after severe orbital trauma as it refines the volume and the location of the orbital spacer to achieve accurate restoration of ocular position.

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