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Case Study
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Infra Orbital Defects Treated with Molded Bone Graft: A Case Series

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Abstract

Mid face fracture leads to injuries involving orbits, Medial wall followed by orbital floor being the most commonly affected. We cover here orbital floor fractures resulting into defects. This article is an attempt to put forward the idea of why molding the iliac autogenous bone graft should be done to fit the curvature of the orbital floor. By changing the degree of curvature of the harvested graft, it fits snugly into the defect rather than being tented from behind or not sitting well in the defect leading to altered orbital volume. Molding the graft helps re-establish the continuity of the floor while maintaining adequate orbital volume.

Introduction

Road traffic accidents, falls and assaults account for the most common causes of the midface fractures. Orbital fractures are more common in males than in females and most often occur in men, ages 21 to 30 [1]. Orbital floor and medial wall of the orbit are commonly involved in mid face injuries and they have complex mechanism of injury considering the unique orbital anatomy and soft tissue structures.

Although orbit occupies 0.3% surface area of the human body, loss of vision in one or both eye leads to 25% or 85% disability respectively [2], requiring adequate and appropriate treatment for the orbital fractures. When the orbital floor is involved with intact inferior rim it is known as pure orbital fracture and when the rim along with floor is involved it is impure orbital fracture. Pure orbital fracture are seen when a larger object than the globe hits the orbit the globe gets displaced posteriorly increasing the intra ocular pressure, the floor acts as a safety valve with herniation of the peri-ocular contents into the maxillary sinus, thus the globe is spared from the rupture as the force gets dissipated. Converse, Smith, Obear, and Wood-Smith (I967), listed the automobile, the human fist, and the human elbow as the most common etiological factors in a series of 100 cases. Diagnosis Early diagnosis and treatment of a blowout fracture is extremely important since the prognosis in such cases is excellent [3].

Method

We studied the difference in the angles between the orbital floor and inner table of the pelvis of 10 healthy male and female, giving an average difference of curvature of degrees between the orbital surface and inner table of ilium surface. This variance between the degrees makes it necessary to mould the iliac crest graft. It is an observational study done over a period of 2 years. All the patients being operated for the defect was included where in the iliac bone graft was used and those patients, which were treated conservatively and pediatric patients were excluded.

Case Presentation

Operative steps

Repair of an orbital floor defect proceeds in a similar manner regardless of approach. With the patient in supine position, and after all aseptic precaution, a single infra orbital incision over the infra orbital rim. Once the orbital rim is reached, dissection continues in the subperiosteal plane into the orbit and then along the orbital floor in a 20° cephalic direction. Deeper in the orbit a malleable retractor is used to elevate the orbital tissues and improve visibility to identify the orbital fracture defect. Orbital tissue is frequently herniating into the fracture. This tissue should

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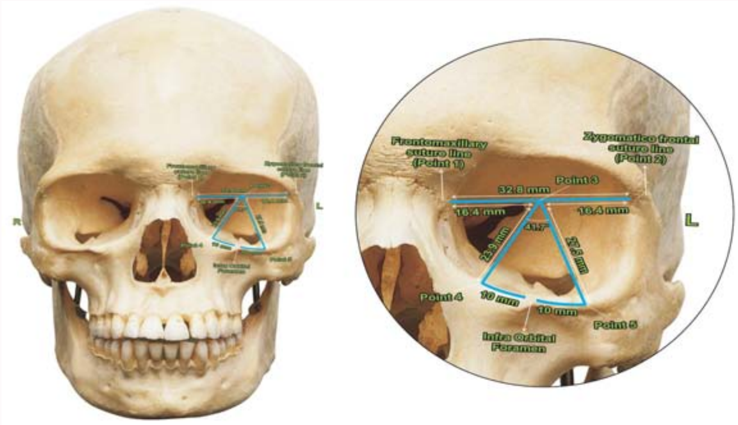

Figure 1A: Measurements demonstrated here on bony window of face.

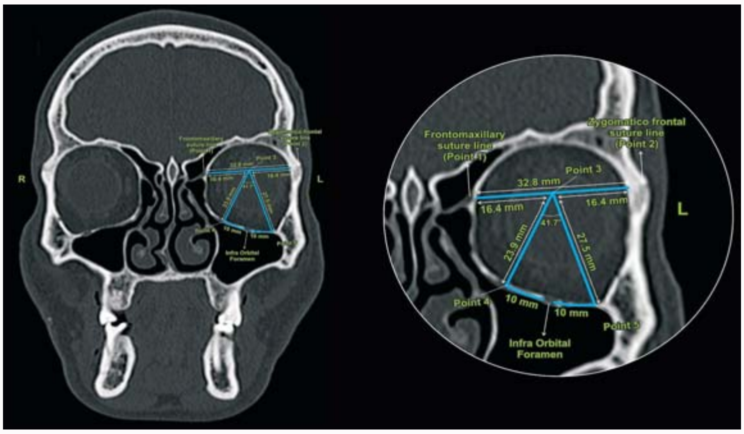

Figure 1B: Measurements demonstrated here on bony window of face in coronal section.

be delicately approached from side-to-side, avoiding inadvertent penetration of the tissue with the freer/elevator. Penetration into the tissue can expose difficult to retract orbital fat, making visibility more cumbersome. Segments of bone limiting elevation of soft tissue can be removed to improve mobility of the orbital tissue back into the orbit. Once the infraorbital nerve is identified, the tissues above and medial to the nerve can be mobilized into the orbit and separated from orbital floor bone fracture segments and the maxillary sinus mucosa. Dissection is continued until the entire orbital fracture can be identified and the bone ledges deemed stable to support an implant (especially important is the posterior ledge).

Three cm posterior to the anterior superior iliac spine (on either side) and incision is kept over the iliac crest and inner table of the crest is reached. A chisel is used to hammer the inner table and the cortical bony chip harvested is cut to the defect size and molded using hand, care should be taken to prevent fracture of bone graft. The graft is placed in the defect and orbital content are gently released. The graft stays put with the orbital pressure. The graft is sized and shaped to cover the fractured defect. The size of the graft should not be significantly larger than the defect as this can affect ocular motility and globe position.

The important point to be careful about is that the graft should not elevate posteriorly increasing the intra orbital pressure. It should settle well into the defect under vision. Closure is done in 2 layers and vision is assessed postoperatively on table before shifting the patient.

The mathematics behind the molding

Orbital fractures involving the orbital floor with the dimension of the fracture exceeding more than 1 cm^2 required repair of the floor to prevent herniation and entrapment of the ocular muscles and orbital content leading to visual disturbances. Multiple options are available to repair the floor both autogenous and allogeneic materials. The bone graft harvested from the patient iliac crest itself gives great result as there are no risks of rejection and the graft gets integrated and fibrosed over time to the floor serving the purpose.

The curvature of the iliac crest and that of the orbital floor is not same with inner table of the iliac crest have a gentle curve compared to orbit, thus the bone graft harvested must be molded to fit in to the floor of the orbit. Curvature of each orbital floor also varies in the same person and so does the curvature between the orbital floor and iliac table.

Since the orbit in not an exact sphere in order to measure the degree of curvature present at the floor 1 cm medial and lateral to the infraorbital foramen, a straight line is drawn from Frontomaxillary Suture (FMSL) line [Point 1] to the Zygomatic Frontal Suture Line (ZFSL) [Point 2] to find a constant point in the orbit from where the angle of the required surface can be measured. Two points 1 cm lateral and medial [Point 4 and 5] to the foramen are marked and a triangle is now drawn with apex [Point 3] at the centre of the line 1 with base at the point 4 and 5. Angle at the Point 3 is measured and the distance from 4-3 and 5-3 is taken as radius and an imaginary

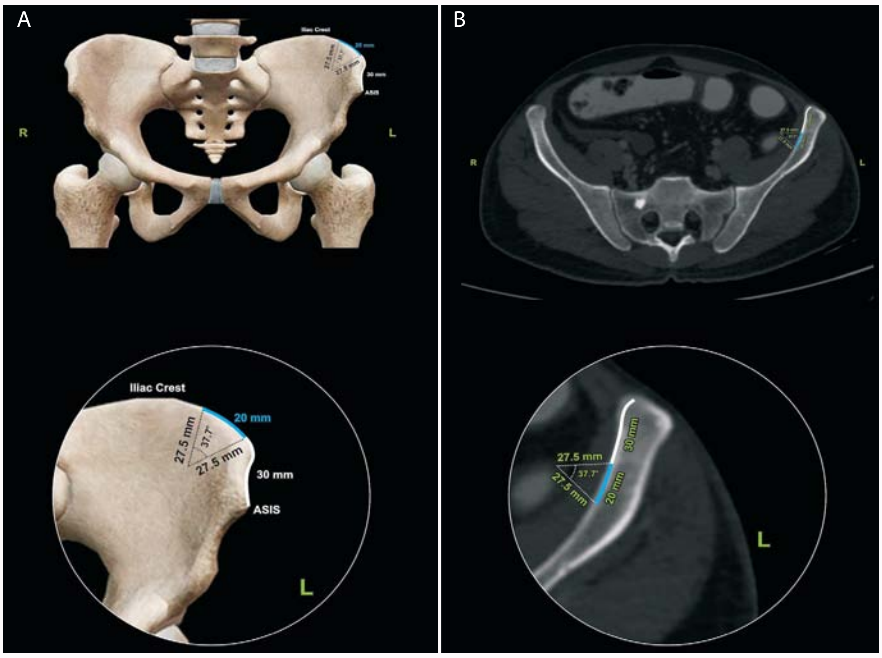

Figure 2: Measurements demonstrated in A) 3D reconstruction, B) Axial view on the left side pelvis.

circle is drawn. The distance between 4-3 and 5-3 will also be variable and thus an approximate average is taken from the two values and we take that radius to get and angle from two points 2 cm away on the iliac crest. We take bone graft of 2 cm, which is harvested 3 cm posterior to the anterior superior iliac spine so as to avoid injuring the lateral cutaneous nerve of thigh (Figure 1, 2).

The difference in angle that we achieve by juxtaposing the same radius we got in orbit, to the pelvis is the amount of molding required.

We can only get an approximate or we can try and understand the requirement of molding by studying the difference of curvature of the orbit and ilium from the patients referred to us. There will never be a fixed degree of molding required as curvatures of the aforementioned surfaces are variable.

Results

There were total 20 patients which were operated in our department over span of 2 years, out of which 13 (65%) were male and remaining were female patients. The age of the patients treated ranged from 19 to 60 years with mean age of 36.55 years. 11 out of 20 (55%) orbital floor fractures resulted from RTA [road traffic accidents] followed by 5 due to fall from height or fall due to loss of consciousness and 2 due to assault. It is an observation of the authors here that the most common side involved was left. Average number of stay was 6.65 days; longest stay was 15 days and shortest stay being 4 days. The patient who had longest stays all had multiple injuries involving various systems.

Those patients that were referred from other department stayed indoor for more days as compared to the average as they had other severe injuries requiring surgical intervention by other department when the patient was deemed fit for major surgical intervention. All patients underwent bone grafting harvested from the iliac crest of the left side.

The highest molding required in male patients was 10 degrees and smallest degree of molding required was 4 degree. The above mentioned figure is just to show how the measurements were taken. The image clearly shows how the radius also varies in the same orbit and average of the same was taken to juxtapose it on the pelvis.

Discussion

Orbital fractures occur as a result of energy transmitted to the globe through direct pressure or to the orbital walls.

Fractures of the orbital floor can be divided into the following two types: "Medial floor" and "complete." A medial floor fractures typically occur with lower velocity injuries, resulting in displacement of the orbital floor between the infraorbital nerve and the medial strut of the lamina papyracea. A complete floor fracture occurs with higher velocity injuries resulting in displacement of not only the thinner bone of the medial orbital floor, but extending across the infraorbital nerve toward the zygomatic bone, thus encompassing the entire orbital floor [4].

As a rule the weakest part of the wall breaks down in response to the energy transmitted. The medial and orbital floor being commonly involved. We will primarily focus on the orbital floor defects here. A defect or fracture in the floor leads to herniation of the orbital fat and other orbital contents, and the orbital volume is increased subsequently. The increase in the volume is directly proportionate to degree of enophthalmos. If the contents are dragged inferiorly into the maxillary sinus the globe follows resulting in hypoglobus. This dragging pull can cause extraocular muscle entrapment leading to globe motility disturbance and diplopia. Nerve, vessel and injury to lacrimal system can also be seen [5].

When a patient presents with classic signs of orbital floor fracture, a CT scan should be performed to evaluate the extent of the fracture. Incarcerated extraocular muscles should be suspected any time CT scan demonstrates the ligamentous sling below the globe is disrupted leading to flattening of the normally rounded inferior rectus muscle. These patients will have gaze restrictions in vertical plane, diplopia and can also possibly be enophthalmic on examination.

Enophthalmos becomes clinically noticeable between eyes at 3 and 4 mm. A 5% increase in orbital volume (1 cm^3) may be enough to cause this finding. In general, this has been defined as displacing more than 1 cm^2 or greater than 50% of the orbital floor. Fracture location is important as well [6]. Thus correcting the defect to prevent the volume from increasing is important.

Primarily the materials used in the treatment of the fracture repair are divided into autograft and allogenic, the most widely used material was and is autograft; the allogenic material is gaining popularity due to better engineering and biocompatibility. However at out institute we still believe that autograft is the best material which can be used and thus we harvest the bone from the iliac crest. There are advantages and cons to every material available on market but with autogenous graft the chances of foreign body reaction or rejection are very slim and the bone used gets osteointegrated and fibrosed in the long run, providing the support to the orbital content. The autogenous bone graft has the following properties, it is -

Non carcinogenic

Non allergenic

Non inflammatory

Chemically inert

Easily available

It can be molded on the table according to defect size

Maintains the volume of the orbit over time

It is cheaper compared to using an implant

IT is already sterile and compatible

However, an ideal implant should be radiopaque for radiological evaluation and can be removed easily, the cost of harvesting the autogenous graft is minimal but it does give donor site morbidity and increases the operating room time, and eventually gets fibrosed due to reabsorption.

Titanium, porous polyethylene (or combinations of the two) are some of the most commonly used materials today in the orbital floor reconstruction. Recent advancement in computer-aided design has allowed the development of both preformed and patient-specific alloplastic implants where in orbital floor reference is taken from the opposite and the normal orbit. The curvature between the two orbital floors also varies in the same individual so harvesting the bone graft and molding according to the requirement is more appropriate [4].

We have used autologous ilium for the defect here, and though achieving and exact degree of molding required to fill the defect is not possible we can only conclude that.

Conclusion

Molding the bone graft harvested from the iliac crest helps the graft to settle well and occupy the infraorbital defect snuggly, thus maintaining the continuity of the floor without compromising the volume of the orbit. Maintaining the orbital volume and correcting the defect is of utmost importance to avoid herniation of the orbital contents into the maxilla and avoiding enopthalmos. Increase in the orbit volume also has to be avoided to prevent visual disturbance in view of increased intraocular pressure.

The amount of molding required is subjective to the difference in curvature according to each individual but the procedure of molding will provide the smooth continuity of the floor.

The ideal material for orbital floor fracture repair is one that is resorbable, osteoconductive, resistant to infection, minimally reactive, does not induce capsule formation, has a half-life which would allow for significant bony in growth to occur, and is cheap and readily available.

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