# Titanium Mesh Reconstruction of Orbital Roof Fracture with Traumatic Encephalocele: A Case Report and Review of Literature

Nitin J. Mokal, M.S. (Gen. Surg.), M.Ch., D.N.B. (Plast. Surg.)[1]
Mahinoor F. Desai, M.S. (Gen. Surg.), D.N.B. (Plast. Surg.)[1]

[1] Department of Plastic Surgery, Bombay Hospital Institute of Medical Sciences, Mumbai, India

Cranial Maxillofacial Trauma and Reconstruction 2012;5:11–18

**Address for correspondence and reprint requests** Mahinoor F. Desai, M.S. (Gen. Surg.), D.N.B. (Plast. Surg.), C/12, Khalakdina Terrace, August Kranti Marg, Mumbai 400036, India (e-mail: mahinoord@gmail.com).

## Abstract

Orbital roof fractures are rare. Traumatic encephaloceles in the orbital cavity are even rarer, with only 21 cases published to date. Orbital roof fractures are generally encountered in males between 20 and 40 years of age following automobile collision. We report a case of an orbital roof fracture with traumatic encephalocele into the left orbit. Early diagnosis and treatment are very important because the raised intraorbital pressure may irreversibly damage the optic nerve. Computed tomography with 3-D reconstruction, the imaging modality of choice, showed the displaced fracture fragment deep into the orbit. Reconstruction of the orbital roof should be performed in every case. We used an extracranial approach to elevate the fracture with titanium mesh to stabilize the fragment. The cosmetic results were excellent but delay in treatment was responsible for delayed recovery of vision. The case report is followed by a brief overview of orbital roof fractures including pertinent review of literature.

**Keywords**
- ► orbital roof fracture
- ► traumatic encephalocele
- ► titanium mesh reconstruction

## Case Report

An 18-year-old male patient presented with history of motor vehicle accident with trauma to the left fronto-orbito-maxillary region. On admission, his Glasgow Coma Scale was 6/15. Local examination revealed contusions and sutured lacerations of the left forehead and eyebrow, proptosis and hypoglobus of the left eye, with conjunctival chemosis and prolapse and exposure of lower half of the cornea (►**Fig. 1**). Visual acuity could not be assessed because of the altered mental status but pupils were reacting to light albeit sluggishly in the left eye. Computerized tomographic (CT) scan revealed fracture of the left orbital roof with displacement of the fracture fragment deep into the orbit (►**Fig. 2A, 2B, 2C**). There was also associated frontal lobe hemorrhagic contusion and herniation of the brain through the defect in the roof into the orbit. There were comminuted, depressed fractures of the frontal bone involving the frontal sinus and anterior cranial fossa with fracture displacement of the left zygomaticomaxillary complex. There were no fractures around the orbital apex or impinging on the optic nerve.

We faced two problems with this patient. The first one was delay in the diagnosis; patient was referred to our unit 5 to 6 days postinjury when the orbital edema and conjunctival prolapse were already quite severe and corneal exposure keratitis had set in. The second problem was the raised intracranial pressure (ICP), which caused reluctance on the part of the neurosurgeon to intervene and elevate the orbital roof fracture for fear of further increasing the brain edema and ICP. This further delayed the surgical treatment by 5 days. Finally, a consensus decision was reached to do a limited intervention through an extracranial approach.

The left eyebrow laceration was reopened with medial and lateral extensions to expose the supraorbital region (►**Fig. 3**).

**received**
January 2, 2011
**accepted after revision**
January 28, 2011
**published online**
January 30, 2012



**DOI** http://dx.doi.org/10.1055/s-0031-1300958.
**ISSN** 1943-3875.

**Figure 1** An 18-year-old male patient with proptosis and conjunctival prolapse of the left eye caused by displaced fracture of the roof of orbit.

The periorbital and orbital contents were carefully separated from the fracture fragment, which was found lying deep within the orbit. No attempt was made to separate the contused brain and tattered dura from the bony fragment. Instead the fragment was gently elevated and repositioned in the orbital roof. It was fixed in place with a contoured titanium mesh and 1.5-mm titanium screws (►**Fig. 4A, 4B**). The left zygoma fracture was reduced and fixed at the frontozygomatic and zygomaticomaxillary buttresses. The frontal bone fragments were left untouched in view of the contused brain lying beneath.

The patient had good postoperative recovery. Though the conjunctival edema and prolapse took 2 weeks to subside, the aesthetic results were excellent and patient was able to achieve complete eye closure at the end of 2 weeks (►**Fig. 5A, 5B, 5C**).

Postoperative CT scans (►**Fig. 6A, 6B, 6C**) and X-rays (►**Fig. 7**) at 3 weeks showed stable reconstruction of the

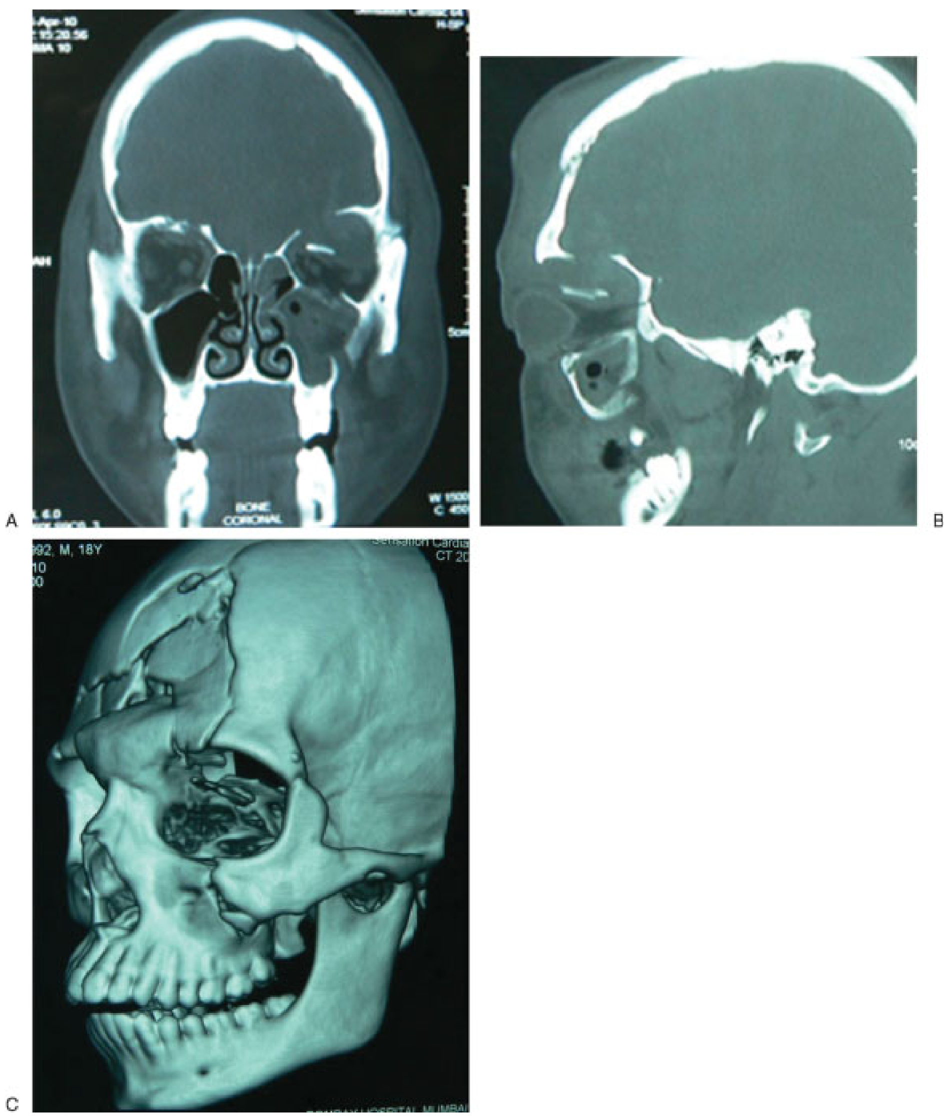



**Figure 2** Computed tomographic scan with (A) coronal cut, (B) sagittal cut, and (C) 3-D reconstruction showing fracture fragment impinging on the eyeball.

**Figure 3** Extracranial approach via left eyebrow laceration.

orbital roof with the mesh in situ and good restoration of roof contour and normal orbital volume.

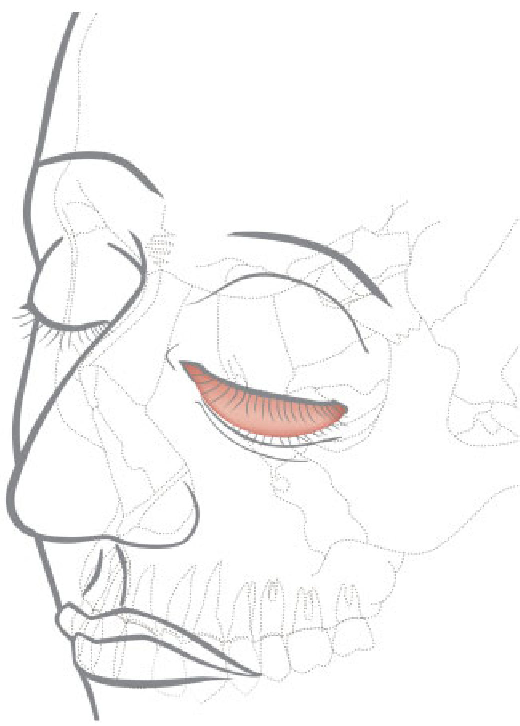
## Discussion

Orbital roof fractures are rare (1 to 9%) in comparison with other facial fractures.[1–3] In adults, the fractures are usually seen in men (89 to 93%) between 20 and 40 years of age following a motor vehicle accident.[2] The common mechanism of injury is high-impact blunt force vector to the forehead or orbit. Orbital roof fractures most commonly coexist with other craniofacial injuries, which can be potentially life-threatening. The typical patient has frontobasal displaced or undisplaced fracture (53 to 93%) and concomitant multi-systemic injuries (57 to 77%).[2] In a study by Martello and Vasconez, 54% had frontal sinus fractures and dural tears were present in 14/58 patients, traumatic encephalocele in 3/58, proptosis in 6/58, pulsatile proptosis in 3/58, orbital apex syndrome in 1/58, persistent cerebrospinal leak in 3/58, and meningitis in 3/58 patients.[3] Hence neurosurgical consult is always required in these cases. Traumatic encephaloceles following orbital fractures are extremely rare with only 21 cases published to date.[4]

Ophthalmic evaluation is mandatory to document visual acuity and assess for common causes of visual impairment including optic nerve compression or laceration, retrobulbar hemorrhage, globe rupture, detached retina, and intraorbital emphysema.[5,6]

Thin-slice CT scan with 3-D reconstruction is the imaging modality of choice for assessment of orbital fractures,[5,7] as the surgeon can delineate the degree of fracture displacement and need for reduction as well as any intracranial injury. Though superior in visualization of intraorbital soft tissues including the optic nerve, magnetic resonance imaging is of limited value in acute orbital injuries due to its insensitivity to assessment of bone fragments and wood/glass particle foreign bodies, and its relative contraindication in case of ferromagnetic foreign body in the vicinity of the orbital tissues.[5]

Reconstruction of the orbital roof is the key step and should be performed in every case of displaced fractures impinging on the globe.[8] There are two approaches to the



A

B

**Figure 4** (A) Fracture exposed through left eyebrow incision. (B) Mesh fixed to supraorbital rim with 1.5-mm titanium screws.

A B C


**Figure 5** Postoperative photos at 2 weeks showing good aesthetic result: (A) frontal view, (B) complete eye closure, and (C) worm's-eye view.

orbital roof: the transcranial and the extracranial approach. The transcranial approach is commonly performed through a bicoronal incision for a frontal craniotomy. This is advantageous because intracranial injuries can also be dealt with at the same time.[4] It must be stressed that the coexisting neurocranial, frontal sinus, and supraorbital rim fractures take priority over the management of orbital roof fractures. The extracranial approach is generally through a superior blepharoplasty incision[2] or through a preexisting laceration, as we have done.

There is a wide variety of materials available for reconstruction of the orbital roof including bone grafts, high-density porous polyethylene (Medpor), titanium mesh (TiMesh), and composites (Medpor with TiMesh, Synthes Medical Ltd., Switzerland).[2,9] The ideal material for roof reconstruction should allow bending to an anatomic shape, be radiopaque (to allow for postoperative radiological confirmation of placement), and be stable over time.

Bone grafts are optimally biocompatible and radiopaque, have a smooth surface from which periorbita can be easily dissected in secondary reconstruction, and have no additional cost. The disadvantages are longer operating time, additional donor site (calvarium, ribs, iliac crest) with the attendant morbidity, and increased operating time and chances of resorption. They also require additional implants in the form of plates and/or screws to hold them in place.[2,9,10]

High-density porous polyethylene (Medpor) is stable, biocompatible, easily contoured and allows tissue incorporation with low risk of infection; no additional donor site is required.[8,11,12] Relative disadvantages include its radiolucency, high cost, and requirement of additional implants to fix the sheet.[11–13]

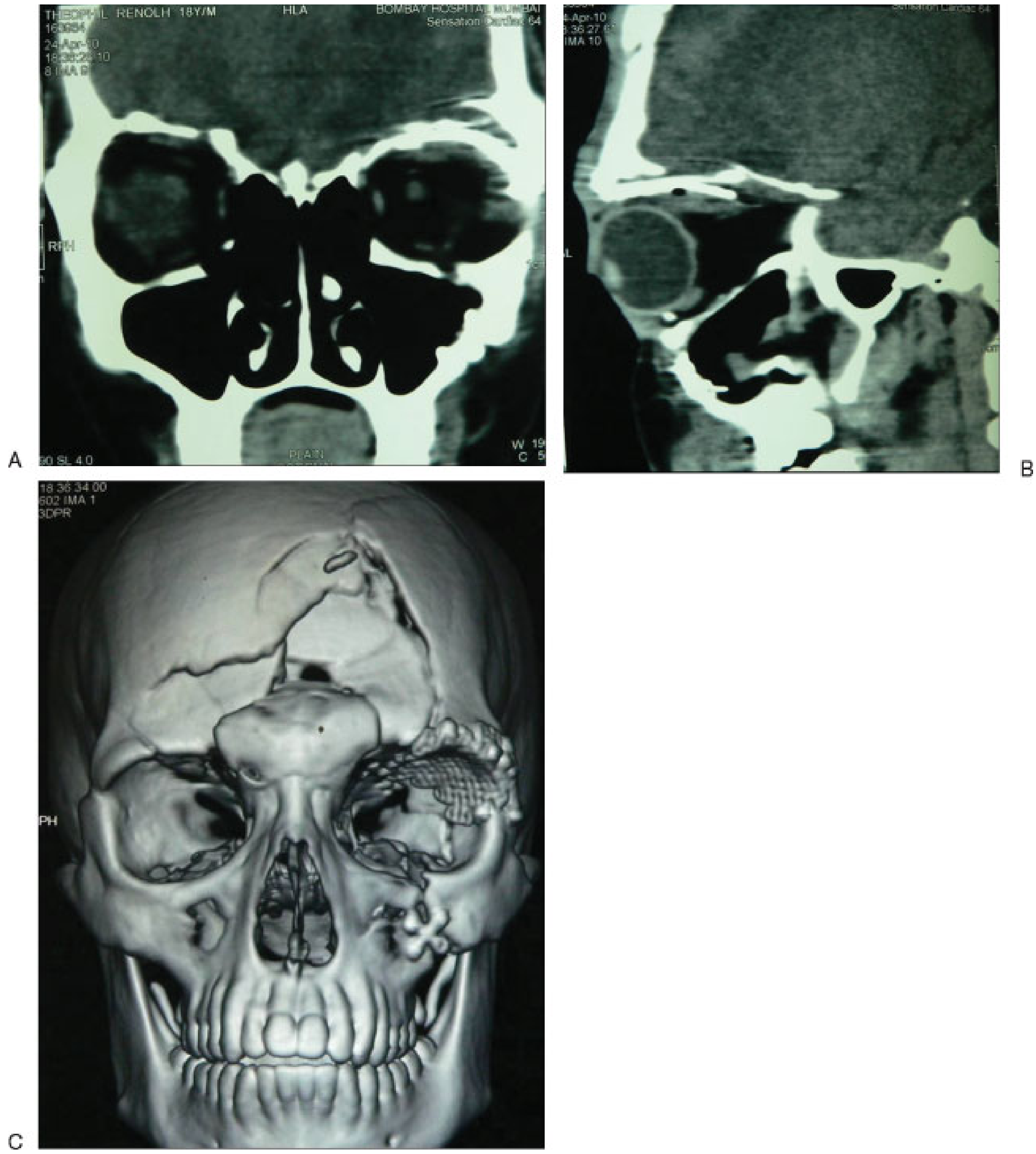



**Figure 6** Postoperative computed tomographic scan at 3 weeks with coronal cut (A), sagittal cut (B), and 3-D plate (C) showing the radiopaque titanium mesh perfectly fitting the contour of the orbital roof with stable reduction of the fracture fragment.

Titanium mesh is available in a wide variety of shapes and sizes including preformed anatomic orbital plates. The advantages include ease of contouring, which makes it quick and decreases operating time, radiopacity, low risk of infection, and stability, and no additional donor site is needed.[2,9,14,15] The spaces within the mesh allow for drainage of fluid and may allow tissue ingrowth. The disadvantages of titanium mesh are the high cost and possible sharp edges if not properly trimmed.[14]

By combining titanium mesh with porous polyethylene, the composite becomes radiopaque and more rigid than Medpor of similar thickness with the added advantages of stability, ease of contouring, and tissue incorporation, which are common to both materials. Regardless of the material used, the intraoperative steps include good exposure via the previously mentioned incisions, identification of the fracture fragment(s) within the orbit, separation of the orbital soft tissues from the fracture, and elevation of the fragment to its anatomic position. It may be necessary to reduce or remove any bone fragments that mechanically restrict the superior rectus muscle or impinge on the levator muscle. Removal of contused herniated brain and intracranial foreign bodies and repair of dura are performed as required. Modern-day techniques like 3-D C-arm technology[16] and navigation[17,18] will further improve intra-operative control of fracture reduction and implant positioning. Navigation facilitates reconstruction in unilateral defects through mirroring techniques and in bilateral defects by importing virtual models from standard CT data sets, improving the software tool to fulfill the need for maxillofacial surgery reconstruction.[19] The implant should be contoured to the shape of the roof and inserted with adequate retraction of the soft tissues to prevent its deformation during insertion. This will also avoid entrapment of periorbita, fat, or muscles within the pores of the mesh.

**Figure 7** X-ray of paranasal sinuses. Waters' view shows titanium mesh in situ along the roof of the orbit.

The implant's posterior extent should remain at least 1 cm anterior to the optic canal entrance. The mesh should always be fixed with titanium screws (or plates in case of other implants) of the appropriate size (1.0, 1.3, or 1.5 mm) for the chosen mesh. Whatever the method of fixation (anterior or posterior to the supraorbital rim), the upper eyelid function must not be compromised. A forced duction test can be performed at the end of surgery to ensure that the implant does not restrict ocular motility.

Complications associated with orbital roof injuries can be categorized as those attributed to the following: concomitant injury, surgical access, postreconstruction volume discrepancy, muscle entrapment, hemorrhage, and/or infection.[2] In children, a rare entity termed "growing fracture of the skull vault" may result if the initial trauma is missed.[20,21] Postoperative follow-up includes a CT scan at 3 months to ensure stability of fragment position, sealing of the skull base, and pneumatization of the frontal sinuses. Some authors recommend frontal sinus obliteration at the time of the initial surgical repair to avoid the late complication of a frontal sinus mucocele.[18]

Posttraumatic meningitis has been reported to occur even decades after the initial trauma.

## Conclusions

Acute traumatic encephalocele related to fracture of the roof of the orbit is rare.[4,8] Early diagnosis and treatment are very important as raised intraorbital pressure may damage the optic nerve.[8] In our patient, delay in the surgical decompression of the orbit resulted in the delayed recovery of vision despite good aesthetic correction of the deformity. Currently available titanium mesh miniscrew and microscrew systems offer a near-ideal modality for orbital roof reconstruction[2] and are a quick, easy, safe and stable method to achieve both the aesthetic and functional goals of reconstruction.

## References

1 Chapman VM, Fenton LZ, Gao D, Strain JD. Facial fractures in children: unique patterns of injury observed by computed tomography. J Comput Assist Tomogr 2009;33;70–72
2 Haug RH, Van Sickels JE, Jenkins WS. Demographics and treatment options for orbital roof fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93;238–246
3 Martello JY, Vasconez HC. Supraorbital roof fractures: a formidable entity with which to contend. Ann Plast Surg 1997;38; 223–227
4 Antonelli V, Cremonini AM, Campobassi A, Pascarella R, Zofrea G, Servadei F. Traumatic encephalocele related to orbital roof fractures: report of six cases and literature review. Surg Neurol 2002;57;117–125
5 Lee HJ, Jilani M, Frohman L, Baker S. CT of orbital trauma. Emerg Radiol 2004;10;168–172
6 Ma C, Nerad JA. Orbital roof fracture with ocular herniation. Am J Ophthalmol 1988;105;700–701
7 Santos DT, Oliveira JX, Vannier MW, Cavalcanti MG. Computed tomography imaging strategies and perspectives in orbital fractures. J Appl Oral Sci 2007;15;135–139
8 Gazioğlu N, Ulu MO, Ozlen F, Uzan M, Ciplak N. Acute traumatic orbital encephalocele related to orbital roof fracture: reconstruction by using porous polyethylene. Ulus Travma Acil Cerrahi Derg 2008;14;247–252
9 Manolidis S, Weeks BH, Kirby M, Scarlett M, Hollier L. Classification and surgical management of orbital fractures: experience with 111 orbital reconstructions. J Craniofac Surg 2002;13;726–737; discussion 738
10 Mohindra S, Mukherjee KK, Chhabra R, Gupta R. Orbital roof growing fractures: a report of four cases and literature review. Br J Neurosurg 2006;20;420–423
11 Rubin PA, Bilyk JR, Shore JW. Orbital reconstruction using porous polyethylene sheets. Ophthalmology 1994;101;1697–1708
12 Romano JJ, Iliff NT, Manson PN. Use of Medpor porous polyethylene implants in 140 patients with facial fractures. J Craniofac Surg 1993;4;142–147
13 Couldwell WT, Stillerman CB, Dougherty W. Reconstruction of the skull base and cranium adjacent to sinuses with porous polyethylene implant: preliminary report. Skull Base Surg 1997;7; 57–63
14 Lazaridis N, Makos C, Iordanidis S, Zouloumis L. The use of titanium mesh sheet in the fronto-zygomatico-orbital region. Case reports. Aust Dent J 1998;43;223–228
15 Patel MF, Langdon JD. Titanium mesh (TiMesh) osteosynthesis: a fast and adaptable method of semi-rigid fixation. Br J Oral Maxillofac Surg 1991;29;316–324
16 Heiland M, Schulze D, Adam G, Schmelzle R. 3D-imaging of the facial skeleton with an isocentric mobile C-arm system (Siremobil Iso-C3D). Dentomaxillofac Radiol 2003;32;21–25
17 Manson PN, Markowitz B, Mirvis S, Dunham M, Yaremchuk M. Toward CT-based facial fracture treatment. Plast Reconstr Surg 1990;85;202–212; discussion 213–214

18 Stuehmer C, Essig H, Schramm A, Rücker M, Eckardt A, Gellrich NC. Intraoperative navigation assisted reconstruction of a maxillofacial gunshot wound. Oral Maxillofac Surg 2008;12;199–203
19 Schramm A, Suarez-Cunqueiro MM, Rücker M, et al. Computer-assisted therapy in orbital and mid-facial reconstructions. Int J Med Robot 2009;5;111–124
20 Jamjoom ZAB. Growing fracture of the orbital roof. Surg Neurol 1997;48;184–188
21 Manson PN, Iliff NT. Fractures of the orbital roof. In: Hornblass A, ed. Oculoplastic, Orbital and Reconstructive Surgery. Baltimore: Williams and Wilkins; 1990:1139