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Demographical Factors and Complications in Open Globe Injuries

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Abstract
Aim: *To study demographical factors and complications frequently encountered in open globe injuries.*
Method: *Retrospective charts review conducted in a tertiary care center, Sankar Foundation Eye Hospital, Visakhapatnam. Total 35 Open globe injury (OGI)case records from 1 January 2012 to 31 December 2013 identified, Case notes examined to determine demographic data, mechanisms of injury, pre operative vision, location of injury, procedures carried out, post operative vision (day 1, post 3 months), Snellen chart used to record visual acuity, slit lamp examination for recording anterior segment clinical signs and B- scan done for posterior segment findings*
Results: *Almost 1/3rd of patients are below 15yrs, mostly men (75%) encountered injury – attributed to their life style. Type A (rupture) mechanism of injury is common – due to blunt trauma, 66% injuries are in zone 1 – anterior.*
Visual acuity (grade D) gaurded in 60 % cases, Almost 75% of cases had afferent pupillary defect. Hyphaema, Traumatic cataract, choroidal detachment, retinal detachment, vitreous haemorrhage - common complications for less vision. Uveal tissue prolapse is more prone for infection. In zone 1 injuries, 5 cases (17 %) did not turn up for review at 3 months, of the patients who turned up 31% had improvement in vision, In zone 1+2 injuries 2 (25%) patients were lost to follow up, Out of remaining 50% had improvement in vision. This emphasis the need for patient motivation, only 3% of case were operated within 24 hours of presentation. 58% of cases were operated between 24 to 48 hours, 39 % of cases were operated after 48 hours. This shows problem of logistics and finances involved with such sudden events.

Introduction

Ocular trauma is one of the most common causes of vision loss. Blunt or penetrating ocular trauma can lead to vision loss through cataract or zonulodialysis, suluxation and dislocation of Lens, glaucoma, hyphema, cyclodialysis, iridodialysis, vitreous hemorrhage, chorioretinal tear, retinal detachment, ruptured globe with deformed eye wall, optic nerve damage, avulsion, and compartment syndrome, direct or indirect damage to extra ocular muscles. Orbital fracture may cause extraocular muscle entrapment among other distortions to intraocular structures.

Etiologies of ocular injury differ in urban areas compared to other settings, and differ from country to country, between different regions of the world, and between differing demographic or socioeconomic classes. Epidemiological studies can encounter difficulty due to sometimes remote trauma and difficulty obtaining an accurate history. Strategies for prevention of ocular trauma require knowledge of the cause or mechanism of injury, which may enable more appropriate targeting of resources toward preventing such injuries. Both eye trauma victims and society bear a large, potentially preventable burden.

Classification

An open-globe injury includes a full-thickness defect in the cornea and or sclera, can come in many varieties and are sub-classified based on the mechanism of injury. Blunt injury of significant force causes deformation changes of the globe with rapid rise in intraocular pressure. With anterior-posterior shortening of the eye, the eyewall undergoes significant strain and can rupture or burst at weak points. The most common site of rupture in an eye without a history of previous intraocular surgery is under the rectus muscles where the eye wall is the thinnest. In eyes with a previous surgical incision, the rupture usually occurs at the previous incision, even many years later. Modern well-constructed, small, self-sealing cataract incisions may, however, have little tendency to rupture even following severe blunt injury.

Aim

To study demographical factors and complications frequently encountered in open globe injuries.

Method

Retrospective charts review conducted in a tertiary care hospital, Sankar Foundation Eye Hospital, Visakhapatnam. Total 35 Open globe injury (OGI)case records from 1 January 2012 to 31 December 2013 identified, Case notes examined to determine demographic data, mechanisms of injury, pre operative vision, location of injury, procedures carried out, post operative vision (day 1, post 3 months), Snellen chart used to record visual acuity, slit lamp examination for recording anterior segment clinical signs and B- scan done for posterior segment findings.

All cases classified according to Open Globe Injury Classification

Open Globe Injury Classification:

Type	Pupil	Grade (visual acuity)	Zone
A. rupture	1) Positive, relative APD in injured eye	A. ≥20/40	1. Cornea and limbus
B. penetrating	2) Negative, relative APD in injured eye	B. 20/50 to 20/100	2. Limbus to 5 mm posterior into sclera
C. IOFB		C. 19/100 to 5/200	3. Posterior to 5 mm from the limbus
D. perforating		D. 4/200 to PL	
E. mixed		E. No PL	

Zone 1

- Surgeries conducted for zone 1 injuries
- corneal tear repair ± iris abscission ± lens aspiration ± anterior vitrectomy ± peripheral iridectomy + intracameral antibiotic / antifungal under GVP

Second surgeries

- 5 lens aspirations
- 1 pkp + lens aspiration

Zone 2

- scleral tear repair ± uveal tissue excision ± vitrectomy done

Zone 1+2

- Corneoscleral tear repair ± iris abscission ± anterior vitrectomy ± i/c AB given

Zone 3

- 1 - tppv+suprachoroidal drainage+soi
- 1 - sics + bb + tppv+iofb removal +pfcl+el+aae+soi

Results

Almost 1/3rd of patients are below 15yrs, and most of the injuries are in zone 1. Less than 10% of cases are recorded in age group > 50 yrs. 1/4th of cases occurred in zone 1+2. Mostly men (75%) encountered open globe injury. All zone 1+2 injuries have been reported in men. (Table1&2)

Table 1.OGI Age distribution

CLASS INTERVAL	Zone 1	Zone 2	Zone 1+2
1-15 yrs	11 (31%)	1 (3%)	1 (3%)
15 – 30 YRS		2 (6%)	3 (9%)
30 - 40 YRS	8 (23%)		2 (6%)
40 – 50 yrs	2 (6%)		2 (6%)
50 – 60 YRS	1 (3%)	1 (3%)	
>60 YRS	1 (3%)		

Table 2. Sex distribution

Sex	Zone 1	Zone 2	Zone 1+2	total
Male	16	3	8	27
Female	7	1		8
total	23	4	8	

Table 3. At presentation Type of injury / Visual acuity / Pupil Grading distribution Zone wise

	Zone 1	Zone 2	Zone 1+2
	Type A (23)	Type A (4)	Type A (7), Type C (1)
Visual acuity			
	2 (6%)		1 (3%)
	1 (3%)		
	2 (6%)	1 (3%)	
	15 (43%)	2 (6%)	7 (20%)
	3 (9%)	1 (3%)	
Pupil			
	19 (54%)		7 (20%)
	4 (11%)	1 (3%)	1 (3%)
		3 (9%)	

- Majority of injuries are of type A.
- 56% of all cases had Grade D vision
- Grade D vision was reported in 60% of cases in Zone 1, 50 % of cases in zone 2 , and 88% cases in zone 1+2
- In 4 cases, vision not recorded as patients age less than 4 yrs

Table 4. Anterior segment complications

Pre op complications	Zone 1(/23)	Zone 2 (/4)	Zone 1+2 (/8)
Iris incarceration / prolapse Uveal tissue prolapse	14 (61%)	2 (50%)	3 (33%)
Iridodialysis	2 (9%)		1 (12.5%)
Hyphaema	7 (30%)	4 (100%)	1 (12.5%)
Hypopyon	6 (26%)		
Traumatic cataract	13 (57%)	1 (25%)	1 (12.5%).
Anterior subluxation of lens	1 (4%)		
Corneal infiltrate	1 (4%)		
Graft ectasia	1 (4%)		
IOL expelled	1 (4%)		
Vitreous prolapse	1 (4%)		

- Almost 75% of cases had afferent pupillary defect, in 3 cases of zone 2 , pupil reaction not recorded due to total hyphaema
- Iris prolapse (50%) is most common complication occuring in all zones
- Hyphaema is present in all cases with zone 2 injury and 12.5% of cases with zone 1 +2 injuries
- Hypopyon was present in 26% of cases with zone 1 injury and was not present in zone 2 or zone 1+2 cases
- Traumatic cataract was seen in 57% of cases with zone 1 injury and was seen in 25 % of zone 2 injuries and 12.5% of zone 1+2 injuries

Table 5. Posterior segment complications

Pre op complications	Zone 1	Zone 2	Zone 1 +2
Choroidal detachment			2(25%)
Vitreous hage	3 (13%)	2 (50%)	3 (37%)
Retinal detachment	2 (9%)	1 (25%)	3 (37%)
PVD		1 (25%)	
Vitreous membranes	3 (13%)		
Suprachoroidal hage			1 (12.5%)
IOFB			1 (12.5%)
Endophthalmitis	1 (4%)		
RCS thickening	1 (4%)	1 (25%)	1 (12.5%)

- Choroidal detachment was seen in 25% of cases with zone 1 +2 injuries, 50% of cases with zone 2 Injuries had vitreous haze and it was 13 % in zone 1 injuries and 37 % in zone 1+2 injuries.

- Retinal detachment was seen in 37% of zone 1 + 2 injuries 27% in zone 2 injuries and 9% of zone 1 injuries
- IOFB was seen in 12.5% of zone 1+2 cases

Table 6. Time interval from presentation and surgery

zones / time interval	<24 hrs	24-48 hrs	> 48 hrs
Zone 1	1	10	12
Zone 2		2	2
Zone 1+2			1

Only 3% of case were operated within 24 hours of presentation, 58% of cases were operated between 24 to 48 hours, and 39 % of cases were operated after 48 hours

Table 7. Comparision of pre op and post op vision

	Zone 1			Zone 2			Zone 3		
	Pre op vision	Post op day 1 vision	Post op 3 months	Pre op vision	Post op day 1 vision	Post op 3 months	Pre op vision	Post op day 1 vision	Post op 3 months
Grade A	2	3	4				1	1	1
Grade B	1	1	3						3
Grade C	2	1	4	1	1	1			
Grade D	15	15	5	2	2	2	7	7	2
Vision not recorded	3	3	3	1	1	1			

- In zone 1 injuries 17 % cases did not turn up for review at 3 months
- Of the patients who turned up 31% had improvement in vision
- In zone 1+2 injuries 25% patients were lost to follow up
- Of those coming for follow up 50% had improvement in vision

Table 8. Post operative complications

	Zone 1	Zone 2	Zone 1+2
K infiltrate / K edema	4	1	
Fibrin	3		1
Hypopyon	1	1	
Hyphaema	1	2	3
AC shallow	1		
Iris bombe formation / Posterior synaechiae	3		
Iridodialysis	1		1
Traumatic cataract	5		1
Aphakia	2	1	
Vitreous haemorrhage	1	1	
Total CD	1		2
Posterior dislocation of lens		1	1

Summary and Conclusions

Almost 1/3rd of patients are below 15yrs, mostly men (75%) encountered injury – attributed to their life style. Type A (rupture) mechanism of injury is common – due to blunt trauma, 66% injuries are in zone 1 – anterior. Visual acuity (grade D) gaurded in 60 % cases, Almost 75% of cases had afferent pupillary defect. Hyphaema, Traumatic cataract, choroidal detachment, retinal detachm-ent, vitreous haemorrhage - common complications for less vision. Uveal tissue prolapse is more prone for infection. In zone 1 injuries, 5 cases (17 %) did not turn up for review at 3 months, of the patients who turned up 31% had improvement in vision, In zone 1+2 injuries 2 (25%) patients were lost to follow up, Out of remaining 50% had improvement in vision. This emphasis the need for patient motivation, only 3% of case were operated within 24 hours of presentation. 58% of cases were operated between 24 to 48 hours, 39 % of cases were operated after 48 hours. This shows problem of logistics and finances involved with such sudden events.

Diagnosis and management of in open globe injuries

Proper care for patients presenting with this type of injury requires a systematic approach to the diagnosis and management, but more than other ocular disease processes, managing the open globe calls for creativity and flexibility of surgical approach tailored to the specific case. Although there are no specific guidelines for ocular trauma and its sequelae, evaluation and appropriate management of open globe injury at a center familiar with traumatic cataract can facilitate more successful treatment and avoid complications associated with cataract surgery in these cases. Close follow-up after the inciting event can prevent the sequelae of trauma.

1. Diagnosis

Clinical suspicion should be high for the possibility of an open-globe injury in all trauma cases. Direct particular attention to cases involving grinding or hammering, since these continue to be the most common cause of penetrating and intraocular foreign body (IOFB) injuries. Patients with a history of significant ocular and periocular blunt trauma should be considered ruptured until proven otherwise. The diagnosis of a ruptured globe can be difficult given the periocular and ocular swelling, and since the rupture often occurs under the rectus muscles, the wound may be occult.

1.1 History

On initial exam, the patient's consciousness level is assessed. It is important to establish mechanism of injury including blunt or penetrating, velocity of impact or projectile, point of impact, material, and any other details relevant to overall energy of impact. was the patient attacked by a fist, a large blunt object with high velocity and force or a metal shaving, a small sharp object with high velocity

- Was the event witnessed?
- Was the patient wearing protective eyewear (if applicable)? Were any visual changes noted soon after the trauma?
- Does the patient use anticoagulant medications (suggesting that a bleed may have formed in the anterior chamber)? Any other systemic diseases?
- Is there a personal or family history of sickle cell disease or trait?
- Any ocular history or previous ocular surgeries? Any other personal medical history or pertinent family history?
- Is the patient's tetanus vaccination up-to-date?

1.2 Clinical evaluation

1. Introduction

General and comprehensive evaluation of an injured patient and an injured eye is very important to save life and sight. Appropriate analgesia, sedation, and protection of open globe from further injury are an important part of the evaluation. Anti-emetics should be administered to avoid Valsalva maneuver if the patient has nausea or vomiting to prevent possible extrusion of intraocular contents.

2. Systemic Evaluation

- Vital signs should be monitored continuously. Entrapment of an intraocular muscle may lead to life-threatening bradycardia, particularly in children, therefore heart rate should be monitored.
- Brief assessment of other bony and soft tissue injuries must be performed. Once the patient is found to be stable, ophthalmic evaluation can proceed safely.

3. Initial ocular examination Complete ocular examination is important when possible and should begin in all cases with measurement of the visual acuity and testing for the presence of a relative afferent pupillary defect. Poor presenting visual acuity and the presence of an afferent pupillary defect are the most significant prognostic factors that can be detected on presentation. It is important to document these factors for clinical and medical legal reasons. The ophthalmologist should have a high index of suspicion for damage to other parts of the eye when traumatic cataract and/or glaucoma are present. Look for damage to the angle structures, zonular fibers, corneal endothelium, vitreous, and retina with high suspicion. Attention should be paid to the integrity of the lens capsule. Posterior rupture may be occult. Clinical signs of occult rupture include diffuse chemosis, asymmetric deepening of the anterior chamber, low intraocular pressure, hemorrhagic choroidal detachment and vitreous hemorrhage.

4. Visual Acuity: Important predictor for the ocular trauma score, Vision should be tested with correction and pinhole using Snellen's/ETDRS chart. If vision is lower than this, finger counting may be recorded; if this is not possible, hand motion or light perception may be recorded. No light perception is an important consideration, as eyes with this level of vision may show some improvement following proper exploration and management.

5. Pupillary reaction: Relative afferent pupillary defect is an important negative prognostic factor for affected eye. This finding should raise suspicion for optic nerve damage, avulsion, and compartment syndrome if other signs are present.

6. Intraocular Pressure: IOP may be high, low or normal following injury. Low intraocular pressure or hyoptony should raise caution during exam for ruptured globe, and care should be taken to protect the eye from extrusion of contents. The eye should be shielded with when not under examination.

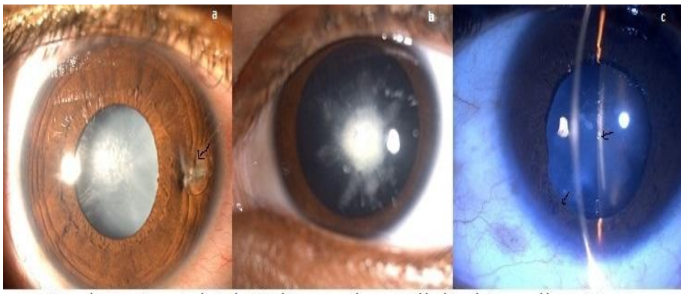
7. Motility: It is important to assess ocular motility as there are chances of direct or indirect damage to extra ocular muscles. Extraocular muscle entrapment must be ruled out.

8. Slit lamp examination:

- Corneal tear with or without iris prolapse and endothelial damage will appear as the formation of Descemet membrane folds (Figure 5) and endothelial dysfunction can result in corneal edema.
- The iris is another commonly damaged ocular structure in the setting of ocular trauma. Examples include: sphincter tears, avulsion of the iris root, and bleeding leading to hyphema as this is a vascular structure. The pupil margin should be examined for irregularities.
- Zonular damage can occur after blunt or penetrating trauma to the eye and can be evaluated by tapping the slit lamp stand or asking the patient to glance quickly left-right then straight to observe movements of the phakic lens relative to the pupillary margin. This can be a sign of phacodonesis.

Evaluation of cataract: Fig 1

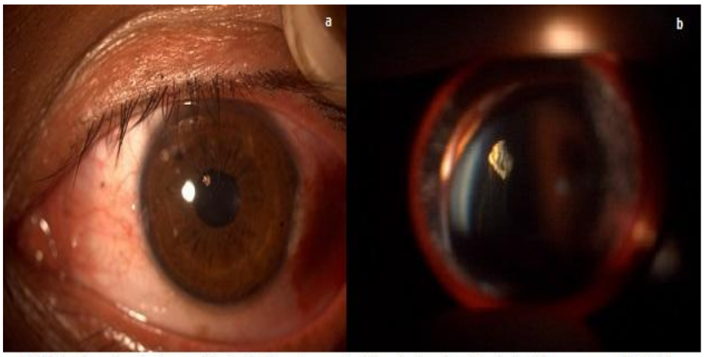
- White soft fluffy cataract: Loose cortical material found in the anterior chamber together with a ruptured lens capsule.
- Rosette cataract: Lens with a rosette pattern of opacity (Figure 1).



a: Traumatic cataract due to refractile Foreign bodywith entry wound in cornea and iris with cortical matter at iris entry, b: Rosette cataract after blunt trauma, c:Ant. sub capsular cataract with inferior sphincter tear

Figure 1 a. fluffy cataract with anterior capsule rupture, b. Rosette cataract, c. Ant Subcapsular cataract

- Cataract may occur acutely after trauma, but more often a slowly progressive cataract develops. Evolution of the cataract can be monitored and surgical intervention can typically be postponed until resolution of the typical intraocular inflammation and potentially increased intraocular pressure associated with trauma. Glaucoma, or damage to the optic nerve, can occur as soon as 2-3 weeks following the trauma event, depending upon the intraocular pressure and other factors, such as hyphema, cyclodialysis, iridodialysis, among other distortions to intraocular structures. The development of glaucoma can also occur months to years later in the setting of angle-recession glaucoma.
- Posterior segment: if a view to the posterior segment is available, the coexistence of retinal detachment, tear, and/or retinal dialysis should be ruled out by scleral depressed examination. This examination should be deferred until the operating room if ruptured globe is suspected even remotely.
- When a patient is sitting upright at the slit lamp, it may be easier to detect a foreign body (fig2&3)than when laying supine under the operating microscope.

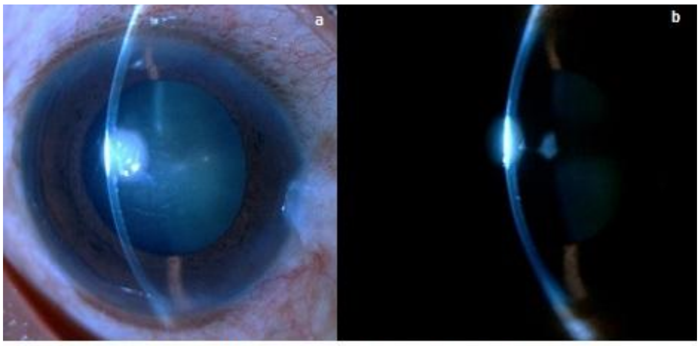


a. Multiple sub conjunctival, corneal foreign bodies after cracker injury, b. intravitreal forign body in same eye with 78D lens

Figure 2 Intra ocular foreign body after cracker bomb blast

- **Intraocular Foreign Body Injuries** In the acute setting when an IOFB is confirmed, urgent intervention is necessary to reduce the risk of infection. Some cases of IOFB-associated Bacillus endophthalmitis may progress rapidly with irreversible damage and rapid loss of the eye. Remember, presence of an IOFB may increase the chance of traumatic endophthalmitis by two to 30 times, although a recent review of traumatic endophthalmitis failed to show IOFB as an independent risk factor for the development of post traumatic endophthalmitis.[1] In the case of a chronic IOFB, the risk of endophthalmitis is negligible and removal of the IOFB is not emergent and based on associated injuries and the possibility of IOFB-related toxicity. The point at which the risk of acute endophthalmitis becomes low, so that urgent removal is not necessary.
-

Fig: Intra lenticular foreign body



a: Thorn injury with endothelial fungal infiltrate, b: fungal infiltrate on anterior capsule

Figure 3 intra lenticular foreign body, **Figure 4a &b** Thorn injury with endothelial ind anterior capsular fungal infiltrate

10. Indirect ophthalmoscopy: Fundoscopic examination be attempted in all trauma patients, however, in the severely injured eye, anterior and posterior segment opacities often limit visualization. If the ocular media is clear, a posterior segment foreign body can be observed by indirect ophthalmoscopy. Care must be taken to avoid pressure to the periocular tissue and globe, if there is ruptured globe exists. B-scan can be performed to characterize intraocular foreign bodies, but must be done with care in open globe injuries. Computerized tomography is the modality of choice in most Emergency Department settings to characterize size, location and material of intraocular foreign bodies. Magnetic resonance imaging is typically not performed if metallic foreign body is suspected as this could cause movement of the object within the eye and further damage to ocular structures.

11. Gonioscopy: Angle recession is “a tear in the ciliary body between the longitudinal and circular fibers” (Figure 7). classic gonioscopic findings include brown-colored, broad angle recess, glistening white scleral spur, depression in overlying trabecular meshwork. Chronically, peripheral anterior synechiae at the border of the recession or anywhere in the angle, damaged iris processes. It is also necessary to assess the presence of a foreign body within the angle, however, gonioscopic examination deferred in open globe injuries as inadvertent indentation pressure can cause extrusion of intraocular contents. X-ray orbits and CT imaging is a preferred modality with 0.5-1 mm cuts through the orbital structures. MRI May be useful in case of patients with non-magnetic foreign bodies but not performed if metallic foreign body is suspected as this could cause movement of the object within the eye and further damage to ocular structures.

12. Measurement of IOP: Leakage of lens protein from a non-intact lens capsule into the aqueous and/or vitreous, as well as non-inert intraocular foreign body, can elevate intraocular pressure as a result of inflammation. Presence of blood in the anterior chamber (fig4. hyphema) can decrease outflow facility of the trabecular meshwork and elevate IOP. Cyclodialysis cleft, ruptured globe, or retinal detachment can cause decreased intraocular pressure. Occult bleeding within the orbit posterior the globe can cause orbital compartment syndrome and elevated IOP. Tight eyelids, difficulty opening the eyelids, proptosis, periorbital edema, and an RAPD are classic signs of orbital compartment syndrome, which is a true ocular emergency.

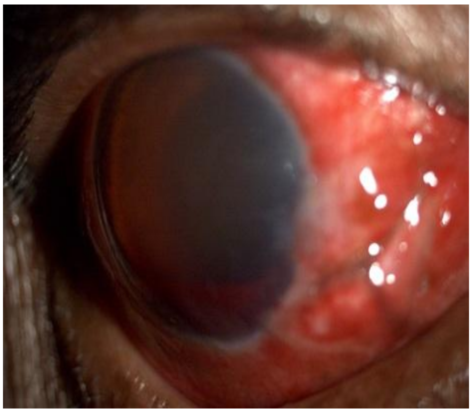


Figure 5 scleral laceration with hypheama

1.3 Diagnostic Procedures

1.3.1 Imaging

- **Plain X ray:** Plain X-ray AP and lateral views are essential to evaluate injured eye and orbit to assess intraocular and extra ocular injuries as well as fractures. It may also detect foreign bodies.
- **Ultrasonography:** B-scan ultrasound is an important investigation but advised to do

with gentleness in case of open globe injuries or can be postponed till primary repair and securing the leak, to detect intraocular and intraorbital damage, especially when ocular media is not clear. B-scan can be used to visualize vitreous hemorrhage, retinal detachment, intraocular foreign bodies, damage to the extraocular muscles, and scleral rupture. It can also offer information on the state of the posterior lens capsule and exudates in vitreous in case of endophthalmitis.

Figure 6 CT Scan: Ruptured globe secondary to blunt injury leading to hypotonous left eye. Source: Dan Gong, MD

- **CT scan:** 1.5 to 2 mm cuts performed in axial and coronal plains (Figure 8). CT is considered superior to ultrasound for locating foreign bodies. This is non-invasive method and does not come in contact with eye which may give us idea about damage to traumatized eye, deformed eye wall, vitreous hemorrhage and retinal detachment. It should be used with caution if ruptured globe is suspected.
- **MRI:** May be useful in case of patients with non-magnetic foreign bodies, and should be used cautiously in cases of magnetic foreign bodies. Indications for use in those with pacemakers or implantable metallic hardware vary by type of hardware.

1.3.2 Electrophysiology

- Full-field electroretinogram: In eyes with no light perception, the full-field ERG is an important method to evaluate the vitality of photoreceptor function.
- Multifocal ERG: This modality may be used to detect which areas of the retina may have been affected.

1.3.3 Laboratory tests

A complete blood count, basic metabolic panel, international normalized ratio, prothrombin time (PT), and partial prothrombin time (PTT) may be required prior to surgery.

2. Management

2.1 General treatment

Management will depend upon time interval between injury and presentation of patient as well as clarity of ocular media, presence of cataract, and degree of IOP elevation if glaucoma is present.

Indications for prompt surgical intervention include the following:

- Presence of cortical material in the anterior chamber is a sign of lens proteins being released, which can lead to phaco anaphylactic glaucoma.
- Preventing visualization: if posterior segment injuries cannot be identified and treated

2.2 Medical therapy

- Broad spectrum oral Antibiotics preferably fluoroquinolone group, as high levels of drug penetration in vitrous body identified with fluoroquinolones, topical antibiotics are differed in case of open globe injuries till globe integrity restored, as high endothelial toxocity and may aggravate inflammatory process due to direct entry of preservatives as well as the drug into anterior chamber. The degree of intraocular inflammation dictates medical management. Topical, periocular and systemic corticosteroids are used in the setting of inflammation without infection.

- Cycloplegics, short-acting and long-acting, are to be used to control pain.
- IOP lowering agents, topical and oral, are to be used in the setting of IOP elevation.
- Start topical corticosteroids to reduce the chances of sympathetic ophthalmitis in other eye 2days after antibiotic coverage.

2.3 Surgery

- Primary vs secondary procedure: In all patients undergoing corneal wound repair, the traumatic cataract may need to be managed in a second procedure. However, there are some who advocate that all repair should be done as primary procedure.
- **Children:** It is important to perform surgeries soon to avoid amblyopia, inflammation also is more in younger children, examination is also difficult. In children younger than 2 years of age, both lensectomy and vitrectomy via a pars plana route is performed, and the same surgical procedures is used to manage the traumatic cataract. Lens implantation as part of the primary procedure was avoided in all children younger than 2 years of age.
- **Anesthesia:** General, local, local and sedation may be used according to anesthetist and surgeon preference. Avoid retrobulbar anesthesia if there is a suspension of a ruptured globe.

Points to take into consideration when planning surgery

- Preoperative intravenous Mannitol 20% 100ml advised in case of open globe injury even though globe is soft, as it will retract the vitreous body and help to manage or prevent further vitreous loss during wound repair.
- Anterior chamber maintainer will be very helpful for maintainig the AC and helpful to maintain the globe distorsion.
- Peripheral iridectomy: Pupillary block glaucoma can occur due to post-traumatic inflammation – a peripheral iridectomy may be considered.
- Viscoelastic substance: serves many functions and are essential in modern cataract surgery, used to protect corneal endothelium and to improve view into the anterior segment, tamponade vessels by increasing IOP, marginalize bleeding, and can tamponade vitreous in areas of zonular incompetence
- Anterior capsule management: Status of the anterior capsule needs to be determined during surgery to plan for location of placement of the intraocular lens. Capsular breaks can extend during hydrodissection and manipulation of the lens. Hydrodiseection should be performed slowly and carefully to minimize the chances of capsular disruption and prevent the lens drop into the posterior segment.
- Nucleus management: The surgical technique selected according to morphology of the lens and the condition of tissues surrounding the lens. Phacoemulsification if small peripheral corneal tear with soft nucleus, or small incision cataract surgery is to be done for cataracts with hard, large nuclei. With a lens that had either a white soft or rosette type of cataract, lens aspiration is used especially if the patient is young. Membranectomy and anterior vitrectomy, either via an anterior or pars plana route, may need to performed.
- Intraocular lens: Location depends upon status of the posterior capsule. In the right conditions, a posterior chamber IOL preferred in adequate capsular support for a posterior chamber, minimal intraocular inflammation and hemorrhage and good view of anterior segment structures. If capsular support is inadequate for a posterior chamber IOL, sulcus IOL, or

plan secondary IOL transsclerally fixated PCIOL, or ACIOL and iris fixated IOL are appropriate choices. Inaccurate keratometry measurements can occur if the patient has scarring from a corneal laceration or if the corneal contour is changing. In these situations, leaving the patient aphakic might be an option, with insertion of an IOL at a later time as a secondary procedure.

4. Selection of IOL

- Patients with a history of uveitis should be spared from silicone lens implants, as inflammatory debris is prone to collecting on the surface of the optic, leading to impaired vision.
- Acrylic lenses are preferred in eyes who need to undergo vitreoretinal surgery in the future or in eyes with a history of uveitis.
- A 3-piece posterior chamber intraocular lens may be placed in the ciliary sulcus of eyes with an intact anterior capsule rim but compromised posterior capsule.
- In eyes without capsular support, sclera fixated IOLs.

5. An anterior vitrectomy must be performed before starting phacoemulsification or cortical aspiration if the vitreous migrated into anterior chamber. Failure to do so may lead to vitreous aspiration and retinal traction.

6. Primary posterior capsulotomy and vitrectomy: Recurrent inflammation is more likely found in patients especially children who had undergone previous surgery for trauma. In such cases; the ocular media will turn hazy due to condensation of the anterior vitreous unless a vitrectomy is performed. Hence, capsulectomy and vitrectomy via an anterior/pars plana route are performed in children and adults.

2.4 Surgical follow-up

- Follow-up is to be scheduled for the post-operative day 1, day 3, week 1, month 1, and month 3. Intraoperative and postoperative complications may require more frequent follow-up.
- At every follow-up examination, visual acuity, intraocular pressure and anterior segment examination is required, and examination of the posterior segment is recommended.
- Periocular and systemic corticosteroids are to be titrated according to degree of inflammation and the risk of IOP spikes.

2.5 Glaucoma Associated with Trauma

Angle recession glaucoma: occurs due to a tear between the longitudinal and circular muscle fibers, both of which make up the ciliary body, and often includes the trabecular meshwork. The development of glaucoma can occur soon after ocular trauma or may develop over the course of months to years. Gonioscopic findings: brown-colored broad angle recess, torn or absent iris processes, white scleral spur, PAS at the border of the recession, and depression in the overlying trabecular meshwork. Initial treatment is medical, although incisional glaucoma surgery may be needed.

Lens particle glaucoma: can occur during the setting of surgical trauma, accidental trauma, or capsulotomy. Lens cortex particles obstruct the trabecular meshwork and can often be seen floating in the anterior chamber. This results in elevated IOP, anterior chamber reaction, micro-cystic corneal edema, development of synechiae. Usually occurs within weeks of initial surgery or trauma, but can occur months to years later.

Phacoantigenic glaucoma: occurs after surgical or accidental trauma, patients become sensitized to their own lens proteins resulting in granulomatous inflammation. Clinical signs include anterior chamber reaction with keratic precipitates on both the corneal endothelium and the anterior lens surface. Treatment is initially with corticosteroids and aqueous suppressants – if more lens matter is present, the lens material can be surgically removed.

Hemolytic or ghost cell glaucoma: may develop after vitreous hemorrhage. In hemolytic glaucoma, trabecular flow is blocked by hemoglobin-laden macrophages, while in ghost cell glaucoma, degenerated red blood cells gain access to the anterior chamber by bypassing a disrupted hyaloid face and obstruct the trabecular meshwork. Glaucoma clears once hemorrhage has resolved.

Trauma-Related Endophthalmitis[3,4,5,6].

Endophthalmitis following open-globe injury is much more common (10 to 100 times more common) than post-operative endophthalmitis. Infection is associated with rural injuries, dirty wounds (injuries caused by an object contaminated with soil or vegetable material fig 4), IOFBs, lens injury, and delay in wound closure. When suspected, immediate treatment initiated with appropriate intravitreal antibiotics, with or without pars plana vitrectomy. The endophthalmitis vitrectomy study (EVS) did not address specifically endophthalmitis associated with open-globe injuries. Many would advocate vitrectomy with intravitreal antibiotics instead of a less invasive approach with vitreous tap and intravitreal injection at the time of wound closure. or closure of wound and perform a vitreous tap and intravitreal injection of antibiotics without a complete vitrectomy. The appropriate antibiotic prophylaxisis with the use of topical as well as systemic antibiotics. In high-risk cases, some even recommend intravitreal prophylaxisis. With the more recent advent of newer fluoroquinolones such as ciprofloxacin and gatifloxicin, therapeutic levels of the antibiotic can be achieved in the vitreous cavity following oral administration.

2.6 Prognosis

The most prognostic factors for poor visual outcome and the need for enucleation are poor presenting visual acuity and the presence of an afferent pupillary defect in the injured eye. Ability to manage the severely injured eye has improved tremendously due to advent of vitreous surgical techniques. Despite these advances, many patients regain very little useful vision following such injuries. Timely and aggressive management of these injuries will offer the patient the best chances to salvage the eye and regain vision.

Visual improvement following surgery for traumatic cataracts is a complex process because it is not only lens which decide visual outcome. Electrophysiological and radio-imaging investigations are important tools for assessing co-morbidities associated with an opaque lens. Morphology of traumatic cataracts and surgical technique may influence final visual outcome. Ocular trauma score is validated value which may forecast visual outcome.

Ocular trauma score[2]

The Ocular Trauma Classification Group analyzed more than 100 variables for over 2,500 eye injuries recorded in the United States and Hungarian Eye Injury Registries(USEIR) developed the Ocular Trauma Score (OTS) with support from the Centers for Disease Control and Prevention (CDC) in order to identify the best predictors of visual outcome at 6 months afteropen globe injury. The score's predictive value is used to counsel patients and their families and to manage their expectations treatment, rehabilitation, and research. It provides guidance for the clinician before pursuing complex, sometimes expensive interventions, particularly in resource-limited settings.

Table 9. Computational method for deriving the OTS score[2]

Initial visual factor	Raw points	
A. Initial raw score (based on initial visual acuity)	NPL =	60
	PL or HM =	70
	1/200 to 19/200 =	80
	20/200 to 20/50 =	90
	≥ 20/40 =	100
B. Globe rupture		−23
C. Endophthalmitis		−17
D. Perforating injury		−14
E. Retinal detachment		−11
F. Relative afferent pupillary defect (RAPD)		−10

Raw score sum = sum of raw points

Table 9: Ocular Trauma Score. [1]*Scott R. The Ocular Trauma Score. Community Eye Health. 2015;28(91):44-5.*

Table 10. Estimated probability of follow-up visual acuity category at 6 month[2]

Raw score sum	OTS score	NPL	PL/HM	1/200–19/200	20/200 to 20/50	≥20/40
NPL: nil perception of light; PL: perception of light; HM: hand movements						
0–44	1	73%	17%	7%	2%	1%
45–65	2	28%	26%	18%	13%	15%
66–80	3	2%	11%	15%	28%	44%
81–91	4	1%	2%	2%	21%	74%
92–100	5	0%	1%	2%	5%	92%

Table 10 Ocular Trauma Score. [2]*Scott R. The Ocular Trauma Score. Community Eye Health. 2015;28(91):44-5.*

How to calculate the Ocular Trauma Score: (1) First, determine the patient's initial visual acuity after the injury and their tissue diagnoses. Second, assign a raw point value for initial visual acuity from row A in Table 1. Then subtract the appropriate raw points for each diagnosis from rows B-F. (For example, a patient with an initial visual acuity of 1/200, scleral rupture, and retinal detachment would receive a raw OTS score of 80-23-11= 46.) Higher OTS scores tend to indicate a better prognosis. To provide an estimate of the patient's probability of attaining a specific visual acuity range at a six-month follow-up, locate the row in Table 2 corresponding to the patient's OTS. (A patient with a raw OTS score of 46 would have an OTS category score of 2.) Table 2 shows the estimated probability of all potential visual outcomes vision after 6 months.

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Further Reading

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