

Ocular Trauma In Blast Injuries

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Eyes comprise as little as 0.27% of the total body surface area and only 0.1% of the erect frontal profile. However, injuries to the eye are found in 10-13% of all combat casualties and, more recently, among civilians having unexpected IED(improvised explosive devices) injury, which has recently increased dramatically

Explosions have the potential to inflict multi-system life-threatening injuries on many persons simultaneously. The injury patterns following such events are result of the composition and amount of the materials involved, the surrounding environment, delivery method, the distance between the wictim and the blast, and any intervening protective barriers or environmental hazards. Blast- related injuries can present unique triage, diagnostic, and management challenges to providers of emergency care

Explosive Devices & Ocular Blast Injury Patterns

Explosives can be categorized as high-order explosives (HE) or low-order explosives (LE). HE produce a defining supersonic over-pressurization shock wave. Examples of HE include TNT, nitroglycerin, dynamite, and ammonium nitrate fuel oil (ANFO). LE create a subsonic explosion and lack HEs over-pressurization wave. Examples of LE include pipe bombs, gunpowder, and most pure petroleum-based bombs. HE and LE cause different injury patterns.

Explosion Related Injuries

Auditory - membrane rupture, ossicular disruption, cochlear damage, foreign body.

Eye, Orbit - Face-Perforated globe, foreign body, air embolism, fractures.

Respiratory - hemothorax , pneumothorax, pulmonary contusion and hemorrhage, A-V fistulas (source of air embolism), airway epithelial damage, aspiration pneumonia, sepsis.

Digestive - Bowel perforation, hemorrhage, ruptured liver or spleen, sepsis, mesenteric ischemia from air embolism.

Circulatory - Cardiac contusion, myocardial infarction from air embolism, shock, vasovagal hypotension, peripheral vascular injury, air embolism-induced injury.

CNS Injury - Concussion, closed and open brain injury, stroke, spinal cord injury, air embolism-induced injury.

Renal Injury - Renal contusion, laceration, acute renal failure due to rhabdomyolysis, hypotension, and hypovolemia.

Extremity Injury - Traumatic amputation, fractures, crush injuries, compartment syndrome, burns, cuts, lacerations, acute arterial occlusion, air embolism-induced injury.

Mechanism of Blast Injuries

The four basic mechanisms of blast injury are termed as primary, secondary, tertiary, and quaternary. Blast Wave (primary) refers to the intense over-pressurization impulse created by a detonated HE. Blast injuries are characterized by anatomical and physiological changes from the direct or reflective over-pressurization force impacting the body's surface. The HE "blast wave" (over-pressure component) should be distinguished from "blast wind" (forced superheated air flow). The latter may be encountered with both HE and LE.

Primary Blast effect

The leading edge of a blast wave, which consists of few millimeters of overpressurized air, is called the blast front and it moves rapidly in all directions from the epicenter of the explosion.

The sudden pressure change caused by the blast wave can damage living tissue through four mechanisms: spalling,

implosion, acceleration-deceleration and pressure differentials.

The air-filled organs and air-fluid interfaces are the organs damaged by dynamic pressure changes at tissue density (i.e., air- fluid) borders due to the interaction of a high-frequency stress wave and a lower frequency shear wave. One or the other of these waves predominates, depending on the characteristics and location of the blast. Ocular/orbital anatomical region containing liquid and other tissue media bounded by thin bone plate walls of air-containing sinuses are also vulnerable.

Secondary Blast Effect

Secondary blast injury is much more common than primary blast injury. Indeed, secondary blast injury is the most common cause of death in blast victims. A large number of blast survivors will have significant eye injuries.?

Penetrating fragments made of different kinds and shapes of objects ranging from explosive material to car fragments, ground particles, sand and other components may cause devastating damage to the eye and body.

In urban explosions, secondary blast causative factors are different in densely populated cities. Glass fragments from windows are notorious for causing ocular injuries. They often do not kill, but can cause blindness and ruptured globes.

Tertiary Blast Effect

Propping of the body against walls or objects, or crush injuries and blunt trauma from building collapse resulting in crush injuries to any part of the body including the eyes/orbital and facial bone trauma constitutes the tertiary blast effect.

Quaternary Blast Effect

Asphyxia through inhalation of fumes from toxic, burnt materials and burns by high thermal explosive effects on the cornea are the key factors in the quaternary blast effect.

Ocular Injuries

Nasal-orbital-ethmoidal injuries

Blast leads to complicated compressed middle third facial skeleton. Reposition by a direct or indirect approach, simple intra osseous wiring or mini plate fixation are enough for proper fixation.

Hyphema

The management is dependent on the cause and severity of the hyphema. Frequently, the blood is reabsorbed over a period of days to weeks. During this time, the ophthalmologist carefully monitors the intraocular pressure for signs of the blood preventing normal flow of the aqueous.

Proptosis

Proptosis may indicate a retro-bulbar hemorrhage. Pupillary distortion may be associated with an open globe. Decreased motility on one side may be caused by an open globe. Other causes include muscle injury, orbital fracture and orbital hemorrhage.

Avulsion of the Eye Globe

The eye is removed and the shell fragment delivered from the retro-bulbar region via a direct orbital approach. The eye socket should be packed with Vaseline gauze, and the fractured maxilla reduced to its position using direct intra-osseous wiring.

Penetrating Eye injury

Although the number of ocular penetrating injuries is high due to conventional combat shell fragments, the number of penetrating eye injuries due to IEDs is far higher (and we should expect this to continue to increase) as the rate of attacks rises in high-risk populated areas.

Indications for surgical exploration in a case of penetrating injury are:

- o Full thickness corneal laceration
- o Full thickness corneoscleral laceration
- o Iris incarceration
- o Suspected IOFB
- o Occult / posterior scleral rupture
- o Endophthalmitis

Tension Pneumo-orbitus (Orbital Emphysema)

Orbital emphysema due to orbital trauma is a well-known occurrence. Visual loss due to orbital emphysema, however, is an uncommon phenomenon.

An overpressurised blast wave front impact leads to implosion of the paranasal air cells; these can allow the passage of air into the orbit space and orbital soft tissues, particularly of the medial orbital wall. The orbital emphysema does not last as it deflates through the fractured orbital walls.

The compartmentalized orbital space holds the compressed air and occasionally creates a one-way valve effect that entraps this air within, or the pressurized air dissected from oropharynx or upper part of pulmonary system. This situation can precipitate proptosis of the globe, elevation of the intraorbital and intraocular pressure, and vascular insufficiency of the optic nerve and retina. The orbit, therefore, follows pressure- volume dynamics, with a pathophysiology, in which increased tissue pressures in an enclosed space are associated with decreased blood perfusion. When the pressure within the orbit exceeds central retinal artery pressure, ischemia results from insufficient blood supply. It is more serious in retroocular hematoma, as the pressure effect of fluid is higher than more diffusible air pressure in tissue anatomical spaces, hematoma can cause a substantial rise in pressure if not treated and may result in blindness if not decompressed by drainage.

Irreversible optic nerve pathology may occur within 90-120 min of ischemia. Front-line surgeons should be familiar with retrobulbar emergent decompression by lateral canthotomy and inferior cantholysis. Canthotomy may compensate for small increases in orbital volume by forward movement of the globe.

Lid lacerations and adnexal injuries

Lid lacerations need to be sutured. Cleaning the skin and removing dust particles and metallic / non metallic. Key to remember is to preserve the skin tissue avoiding excision.

Non penetrating injuries

Blunt trauma to globe can cause damage to anterior and / or posterior segment of eye. Blast injury can present as multiple FBs over conjunctiva and cornea which needs to be removed meticulously sometime under general anesthesia.

Blunt injury can result in subluxation or dislocation crystalline lens. A subluxated lens that becomes cataractous or interferes with patient vision can be removed either using anterior limbal approach, with careful attention to anterior vitreous, or via pars plana.

A variety of retinal injuries may occur with blunt injury to the globe. These include macular hole, peripheral retinal tear, giant retinal tear, retinal dialysis, and avulsion of vitreous base. Management of these injuries depend on nature of retinal injury and / or vitreous hemorrhage. Treatment strategies include laser photocoagulation, scleral buckling and pars plana vitrectomy.

Intra ocular foreign body (IOFB)

IOFB constitutes an emergency and needs to be operated at the earliest. IOFB should be removed if at all possible at the time of initial closer. The presence of IOFB increases the risk of endophthalmitis in acute settings and surgical extraction may be associated with decreased risk of clinical infection. In settings of blast injury multiple foreign bodies in both eyes can be encountered and needs meticulous surgical removal.

Evaluation

Initial evaluation and documentation is important and essential for prognostic, medico legal and comparative purpose. It is not rare that first detailed examination may have to be performed in OT with patient under anesthesia. For this ophthalmologist should be equipped with portable vision charts, direct and indirect ophthalmoscope, magnifying loop, tonometer, fluorescein, anesthetic drops.

o visual acuity

Recording of initial visual acuity is of paramount

importance. It gives indication for severity of injury and also has medico legal implications.

- o Recording of external injuries-lacerations, fracture and deformities, proptosis, enophthalmos, eyelid position
- o Ocular motility
- o Pupils - size, shape, symmetry , RAPD
- o Conjunctiva- laceration, Foreign Bodies (FB)
- o Cornea - abrasions, lacerations, multiple FBs entry wound
- o Anterior chamber- depth, hyphaema
- o Iris - irregular border, tear , iridodialysis
- o Lens- Position, dislocation / subluxation
- o Posterior segment evaluation should be done at the earliest by indirect ophthalmoscopy if possible.

Investigations

Plain X ray-Plain film radiography (PFR) is simplest and most readily available tool.

Computed Tomograahy (CT scan)-The CT scan is a standard diagnostic test for imaging traumatized eye and orbit.

USG scan-It does not require clear media and can be used for detection of suspected foreign bodies when visualization is compromised due to media haze.

Conclusion

In a setting of blast injury attention should be directed to life threatening injuries. Stabilization of patient and treating critical body and limb injuries always take precedence. Ophthalmologist should use systemic medications to control pain, nausea, coughing, and anxiety. Depending on the nature of injury systemic antibiotics can be started prophylactically. Since the blast injury involves multiple foreign bodies, dust and stone particles broad spectrum antibiotics which cover both gram positive and negative organisms should be started. Tetanus immunization status

should be checked and reinforced if required.

The management of such patients is a team effort by critical care specialist and ophthalmologist should be working as part of the team.

Initial resuscitation of the patients remembering ABC (A- airway, B- breathing, C- circulation) of resuscitation is important.

The prognosis for severely injured eyes has improved with the development of advanced microsurgical techniques and better understanding of tissue reaction to trauma. In the immediate period after the injury the rapidity with which treatment is instituted may show an important effect on the final result. In addition, better methods of visual rehabilitations have improved the final visual function.

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