Controversies Regarding the Classification and Management of Traumatic Cataract in the Paediatric Age Group: A Review

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ABSTRACT

Ocular trauma is a topic important cause of preventable monocular blindness all across globe. Pediatric Ocular trauma is the matter of great concern as sight loss in younger age group puts extra economic and social burden. Unresolved controversies and debatable management strategies are to dealt with development of technologies, research We may find evidence based solutions for these debatable points ranging from classifications to management.

Keywords: Pediatric cataract,Traumatic cataract, controvercies, controversies.

Prospective, controlled clinical studies are not possible in open globe injury setting and this article reviews pertinent published work data regarding ocular trauma by various authors across globe, these management issues and controversies discussed and provides recommendations for treatment based on the available published data and the authors' personal experience.

Ocular trauma in pediatric population can be discussed based on:

1. Classification and terminology
2. Epidemiology: Incidence Objects, Activities
3. Evaluation and Predictive models
4. Open globe injuries in children: findings and management
5. Closed globe injuries: findings and management
6. Traumatic hyphema management
7. Traumatic cataract management
8. Post traumatic glaucoma in children
9. Post trauma strabismus + Amblyopia management
10. Management of traumatic endophthalmitis in children
11. Sympathetic ophthalmia in pediatric population
12. Destructive procedures in pediatric population

Ocular trauma in children can cause life-long visual disability and poses a burden to the healthcare system and society.[1]

Children account for approximately one-third of cases of serious eye injuries.[2,3] Despite this, classification and scoring system in pediatric trauma is based on those developed for adults.[4] The controversy over the position of zone 2 and 3 is even more pronounced in pediatric trauma. In the first five years of life the length of pars plana changes rapidly from approximately 1.8mm in neonates to 3mm by one year of age and reaches 5mm by five years of age.[4,5] Hence assessing pediatric trauma for research is fraught with inaccuracies depending on how the injury was classified. Similarly, the Ocular Trauma Score (OTS) was developed to provide more accurate information about visual prognosis. However whether or not children were included in the databases of over 2500 serious ocular injuries from which the method was formulated is not clear.[2]

Management of trauma in children has many similarities

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to adults but striking differences also exist. Foremost is that adults have reached visual maturation whereas amblyopia is a major contributor to poor outcomes in children, especially in those under 5 years old. Most series report less than half of children with open globe injury (OGI) achieve good vision and amblyopia is a major confounding factor.[7,8,9] When treating children with OGI, achieving a clear visual axis following globe repair must be accompanied by accurate refraction and aggressive amblyopia therapy to improve the visual outcomes.[3] Another difference is that a simple examination, especially in the early stages after trauma can prove difficult in a child requiring general anaesthesia or sedation for proper assessment. Involvement of a pediatric ophthalmologist and access to pediatric facilities is therefore essential to ultimate management.

In conclusion, children cannot be treated as just small adults in the setting of OGI. It will probably require a large international collaborative study to define a more accurate trauma scoring system in children. Age of the patient and effects of amblyopia may need to feature as additional negative factors in the prognostic factors.

Classification

International classification of ocular trauma proposed almost fifteen years ago needs revision Many people have tried to relook at classification

Original classification was published by Kuhn et al as Birmingham Trauma Terminology systems, it has provided many definitions and standardized studies across globe.[7] shah et al reinforced by encompassing adnexal, lid and orbital trauma also included classification ocular foreign bodies and validated the same.[8-10] This classification further strengthen by inclusion of many other criteria by Shula et al and further modified.[11]

Finally Integrated Ophthalmic Trauma units, have dedicated Ophthalmic Trauma teams, and routinely adopt the current standard of Ocular Trauma Score guidance, which are to be developed by International trauma registry like I GATES study & participate in it to develop ideal scoring system.[12]

Epidemiology

Incidences, closed open globe, compared with adult Children account for approximately one-third of cases of serious eye injuries.[13-15]

Incidence of closed globe injuries varies from 19 to 84 % in children. Reported activity during trauma is play or fall in majority cases but fire cracker is also reported to cause this sports variable in case of rural and urban population.[13-19]

Shazia Qayum et al reported Out of total patients, 242 (67.8%) presented with closed globe injuryr,[16] while Kajo Bućan1 reported 84.7% cases cases as closed globe injury, Ashok Madan et al reported Most (63.9%) had open and 24.6% had closed globe injuries[17,18] Edita Puodžiuvienė reported closed globe injuries in 55.8% cases[19] but all these studies had smaller databases and study design is retrospective. shah et al has incidence of 19% as closed globe injury.(mas blunt) has reported with larger database of 12687 cases and prospective study Some researchers have reported prospective studies, but these are not specific for closed globe injuries and classified according to BETTS.[15]

Activity and setting during injury important information in case of children play is activity either at home ,school or streets either free play in younger children or sports in elder children. Object of injury is according to socio economical status of children. In case of urban setting writing equipments, toys or domestic injuries but in rural settings wooden sticks, thorn or stones. Several reports suggest injuries by unknown objects as struck something or during fall unknown objects on the floor.[19] Aldoais, reported he majority of injuries (n = 152, 95.0%) had occurred in the street, while eight (5.0%) had happened at home.[20] The most frequent cause of injury was toy guns and fireworks , Batur, reported The most common scene of injury was playgrounds (50.2%)(21) Boret, C., reported The trauma occurred at home (51%) or in a public area (21%). Blunt objects (22%) and direct trauma (17%) were the main mechanisms.[22] Bratton, E studied dog bites to the face occurred in most patients (n = 1, 414 [71%]). Of those children with facial dog bite injuries, 230 (16%) suffered ophthalmic manifestations.[23] Bućan, K studied The majority of traumas occurred in the outside environment (70%, n=249), followed by occurrences at home (17%, n=60), and at a school/nursery (8%, n=28).[24] Injury cause was most commonly "struck by object" (53.7%) and occurred in the home (50.9%) reported by Ferguson, R. A.[25]

Preoperative visual acuity of no light perception and poor visual prognosis: Visual acuity can be profoundly impaired to the extent of no light perception (NLP) in presence of significant media opacity (e.g. corneal edema, hyphema, cataract, dense vitreous hemorrhage), retinal detachment, associated subretinal or subhyaloid hemorrhage, hemorrhagic choroidals and even psychological factors (e.g. hysteria). Assessment of light perception is a subjective measure and not a full proof test in the presence of severe media opacity secondary to dense vitreous hemorrhage, traumatic cataract, dense hyphema and corneal edema.[26]

These assessments are particularly difficult in children almost impossible in toddlers as they are uncomfortable

because of pain and photophobia, important assessment of light perception even with the bright light of an indirect ophthalmoscope can give false impression of NLP.[26] Ultrasonography is useful for assessment of posterior segment in the eyes with media opacity and to differentiate between retinal detachment and vitreous hemorrhage, but it is sometimes difficult to differentiate a detached retina from blood clots in the vitreous cavity or membranes.[27] Before deciding on enucleation in patients with NLP, reversible causes of vision loss should be excluded including psychological factors. Even in situations in which enucleation seems inevitable, the ophthalmologist should discuss the possible options with the patient before making a final decision. Primary enucleation for severely traumatized eyes with NLP in view of risk of sympathetic ophthalmia was a controversial approach. Sympathetic ophthalmia with potential for bilateral blindness is a relative indication for enucleation of an injured eye.[28] Most reported cases (65%) occur between 2 weeks to 2 months after injury and is rare during the first 2 weeks after trauma.[29,30] However the actual rate of post-traumatic sympathetic ophthalmia is not clear, and reported rates vary from 0.28% to 1.9%.(1-4) The use of modern immunosuppressives has also improved treatment and control of sympathetic ophthalmia. As such primary surgical repair should not be abandoned for the risk of sympathetic ophthalmia in eyes with NLP. Currently, most surgeons recommend globe salvaging procedure for eyes with severe trauma with no light perception vision at initial presentation. More over visual improvement is noted in study suggesting many reasons like traumatic optic neuritis and dense central scotoma also may hamper with perception results in improvement following medical treatment.[30]

Investigations

Younger children may not cooperate for examination of anterior or posterior segment. Posterior segment examination may not become possible because of media opacity. Ultrasound B scan along with A scan or Cat Scan tracing is very useful for detection of pathology in posterior segment.[31,32] We may not be able to perform ultra-sonography or ultrasound biomicroscopy in case of open globe injuries

Examination under anesthesia may be very useful for comprehensive examination of a child. Anterior segment oct is also a useful procedure to screen anterior chamber, posterior capsule or zonules.[33-35]

Predictive models

Two of the important factors in calculating the OTS, initial visual acuity and RAPD, are very difficult to obtain in a child after trauma especially in the younger age group, rendering the OTS inaccurate even if possible. The value of the OTS in pediatric patients from age 2 years was assessed recently by two Turkish groups, but the conclusions reached by each were opposing, adding to the controversy.[36] A new Paediatric Ocular Trauma Score (POTS) was published recently with the purpose of refining the prognostic accuracy in children where initial vision is not accurate. Similar to many other series in pediatric trauma, it lacks the statistical power of the OTS due to relatively small sample size and its predictive power remains untested.

A major challenge in the care of eye trauma in children is the precise visual prognosis. Physicians are frequently asked by parents if their child is going blind or if it is going to be able to see again. That is an issue of major concern and, in order to help healthcare providers to appropriately predict final visual outcomes, different ocular trauma scoring systems were developed. The Ocular Trauma Score (OTS) was the first generic instrument; the predicted visual acuity (VA) is estimated by subtracting raw points for five diagnostic findings from the initial VA.[36] Its use in children, however, proved to be less precise probably due to the inability to get accurate VA and prompted authors to develop instruments specifically for pediatric patients.[37-40] The Pediatric Penetrating Ocular Trauma Score (POTS) downplayed initial VA and added age and wound location as two new variables as well as removing the afferent pupillary defect as a prognostic factor.[32] Nevertheless, the POTS was not spared from criticisms.

More recently, the Toddler/Infant Ocular Trauma Score (TOTS) was developed specifically for children under 6 years of age with traumatic open globe injuries. Just like the POTS, it is not reliant on presenting VA and proved to be useful in predicting prognosis in very young children in the United States.[41]

Score calculations and statistical analysis

The POTS was calculated according to Acer et al[36] For each child, the initial VA at presentation was allotted raw points and additional points were added or subtracted for wound location, age, and any of eight concomitant eye conditions. In those patients whose initial VA was not obtained from the medical records, the following equation was used to determine the trauma score:

VA = 2 × (age + zone) corresponding pathologies

Open globe injuries were stratified into three anatomical zones according to its location: if limited to the cornea and limbus, zone I; if located 5 mm posterior to the limbus, zone II; and zone III if the wound was extended

to the macula and optic nerve, posterior to zone II.[40] The resulting score was sorted into 1 (low prognosis) up to 5 (better prognosis).

The TOTS was calculated using high-risk characteristics of injury: wound >6 mm (1 point), hyphema (1 point), cataract/lens damage (1 point), retinal detachment (2 points), and choroidal detachment (1 point).(14) If the sum of points was 0 or 1, then the injury was categorized as low risk (better prognosis); if 2 or higher, as high risk (worse prognosis).[41]

Closed globe injuries

May be closed globe contusion or lamellar laceration when compared with these sub groups lamellar laceration is significantly better.[15]

Clinical manifestations of closed globe contusion

Closed globe contusion of globe may cause choroidal rupture and macular hole in pediatric age group.

Fuller reported "Traumatic choroidal rupture in a six-year-old."[42] Piermarocchi et al. reported "Intravitreal bevacizumab for posttraumatic choroidal neovascularization in a child.[43] Rishi et al. studied "Intravitreal bevacizumab in the management of posttraumatic choroidal neovascular membrane."[44] Secretan et al. reported morphometric characteristics of traumatic choroidal ruptures associated with neovascularization main reason is choroidal rupture throughout fovea or neovascular membrane development using simultaneous SD-OCT or multi modal imaging details may be studied size of seperation may be measured,[45] Guerra, et al. reported "Multimodal Imaging in a Patient with Traumatic Choroidal Ruptures."[46] Surgical removal subretinal haemorrhage may be option to improve vision.[46] In longterm subretinal fibro vascular scar is main reason for non improvement of vision.

One of the manifestations may be macular hole following closed globe contusion is traumatic macular hole[15] Macular hole may coexist with choroidal rupture and subretinal heam. Bosch-Valero reported spontaneous closure of macular hole is common.[47] Bor'i reported cases of TMHs should be observed for spontaneous closure. PPV with ILM peeling should be conducted for nonclosing cases. Gas and silicone oil tamponades are equally successful in anatomical and visual outcome[48] Brennan reported anatomic macular hole closure was achieved in 12 (92.3%) of 13 pediatric cases. Mean preoperative logMAR visual acuity was 0.91 (95% CI 0.65-1.17) with improvement postoperatively to 0.54 (95% CI 0.43-0.64) at 3 months (p = 0.002) and 0.50 (95% CI 0.39-0.60) at 12 months (p = 0.002).[49] Chen suggested rediction of spontaneous closure of traumatic macular hole with spectral domain optical coherence tomography that the absence of intraretinal cysts on SD-OCT can predict spontaneous closure of traumatic macular hole.[50]

Stepankova suggested that pars plana vitrectomy is a safe method for treatment TMH in children without tends to spontaneous closure of TMD in OCT imaging [51] Tsui et al. reported "Progression of traumatic thickness macular hole and retinal detachment in a 3-year-old child."[52]

Wu et al. suggested "Pediatric traumatic macular hole: use of autologous traumatic ectopia lentislasmin enzyme-assisted vitrectomy."[53]

Traumatic ectopia lentis

Closed globe contusion can cause zonular damage ether in form of subluxation or dislocation.[15] Shah et al reported out of 169 cases 26% cases were traumatic. We did not find significant difference according to traumatic and non traumatic aetiologies.[54] management in form of pars plana vitrectomy removal of lens using either vitrectomy or fragmatome. Optical rehabilitation done by secondary lens implant either sulcus, scleral fixated or iris supported.[54]

We found that 70 (41.4%) patients improved by more than 6/24, and 45 (26.5%) did not improve by more than 1/60 because of comorbidities. Out of 169 cases 5.4% were pediatric age group.

Open globe injuries

In case of globe rupture subgroup of open globe injuries zone of injuries varies in incidence and author has reported in 81.5% zone 1 injuries, 9.3 and 9.2 zone 2 and 3 respectively out of database of 417 years over 12 years.(author unpublished data) Andreoli studied the injuries more often were in zones II and III in the geriatric population compared with the nongeriatric population (P < 0.0001)[55] Lesniak studied the most common causes of trauma were: accidents (79%), violence (10%), and motor vehicle accidents (9%). Penetrating ocular injury was the most common trauma (54%), followed by blunt rupture (34%). Zone 1 injuries represented 49% of cases, and zones 2 and 3 represented 29% and 21%, respectively.[56]

Fujikawa studied poor prognosis in zone 3 injuries in children (p=0.04)[57] Altintas reported that isolated Zone I lesions showed more improvement in visual acuity than other zones (p=0.043).[58] Andreol reported the zone of injury may correlate with poor final visual acuity.[55] According to Ustaoglu et al, penetrating injury, zone I injury and pediatric age are good prognostic factors for OGI Injuries in Zones I, II, and III were seen in 40 (35%) eyes), 38 (34%) eyes, and 35 (31%) eyes, respectively, with statistically different

ocular trauma scores ($p<0.01$) associated with each zone of injury.[59] Author has reported zone of injury has significant impact on visual outcome ($p=0.001$) while size and shape did not have impact on visual outcome.(un published data)

General anaesthesia is essential for wound repair but Shah et al. reported combination of regional anaesthesia with sedation particularly for ocular trauma in children,[60,61] Objective is minimal morbidity and hypotony which will facilitate wound repair. Surgical techniques for wound repair may vary according to zones, size and shape of injury.

Debridement and removal of tissue prolapsed in wound is very important for proper wound healing. Prolapsed tissue may be replaced or excised depending upon duration between injury and repair. Tissue debridement may be done manually or using automated vitrectomy hand piece.

Zone-1 repair depends upon location in relation to cornea closure to center smaller bites to be taken using 10/0 mono filament nylon sutures with buried knots.

Zone-2 may be repaired with first suture to limbus and scleral sutures using polygalactyl absorbable sutures after débridement.

Zone-3 repair depends upon extension of wound posteriorly if wound is extending more posterior disinsertion of rectus is essential to access posterior extension of wound.

Bulbar conjunctiva needs to be explored to find out extension of occult wound and manage prolapsed tissue.

Penetrating injuries: small penetrating wound is considered as penetrating in children.

Setting in children is writing equiments like pen, pencil or compass in schools or wooden thorn in rural domestic setting.

Most common manifestation is corneal wound and traumatic cataract, which is having better prognosis. When compared with globe rupture visual outcome is better in children having penetrating injuries.[57]

Traumatic hyphema management in children

Strategies for management, early intervention risk of amblyopia, secondary glaucoma

Blood in the anterior chamber or hyphema can be secondary to blunt ocular trauma. Traumatic hyphema can be associated with one or more major injuries to the eye from the trauma, which could result in a significant reduction in vision. It can be associated with raised intraocular pressure and anterior chamber inflammation. It can get absorbed spontaneously without any surgical intervention however on the other hand there can be secondary bleeding.

Risk in pediatric population and toddlers is amblyopia and we may not be able to wait for longer period like adults.[38-40] Complications resulting from secondary hemorrhage include glaucoma, corneal bloodstaining, or damage to the optic nerve and all these can loss of vision. There is controversy over use of antifibrinolytics and even result in permanent corticosteroids in medical management of hyphema non-drug interventions that were tested included wearing a patch on one or both eyes, moderate activity versus complete bed rest, and elevation of the head versus lying flat.[38] These strategies are not useful in children and toddlers.

In USEIR study by Kuhn et al, damage to the iris or lens, vitreous hemorrhage, and inflammation on baseline examination were associated with a statistically significantly greater risk of developing glaucoma after penetrating ocular involvement. The presence of hyphema and retinal detachment were of borderline significance.[29] In their data they clearly demonstrated that its not the hyphaema but the presence of intraocular inflammation on baseline examination had the highest independent association of any ocular characteristic with the development of post-traumatic glaucoma.[28,29] This is extremely difficult to assess in case of children.

Traumatic cataract: In setting of traumatic cataract, its imperative for surgeon to realize that fact that a traumatic cataract is not a senile cataract. The injury is rarely limited to the lens alone; and it may be associated with injuries to zonules, posterior capsule and posterior segment. A patient with traumatic cataract should be guarded about visual outcome and high risk of intra operative surprises.

At no stage; the ophthalmologist should subject patient to half completed or compromised surgery because of the lack of expertise or infrastructure facility. If the facility is not equipped with providing after-hours the surgeon with the full armamentarium of equipment, instruments, and material, and a full and knowledgeable staff, it is better not to contemplate primary lens removal. In most of the hospitals across world if an open globe injury is seen in late hours, all the state of art facilities is not there to attempt cataract extraction and intraocular lens implantation.

Children and younger patients have stronger adherence between the posterior capsule and the anterior vitreous centrally; and the central vitreous is anatomically connected to the peripheral retina at the vitreous base. Any traction on the anterior vitreous face is transmitted to the retina, and the younger the patient, the greater the risk. Also, the children are at additional risk of amblyopia. In younger

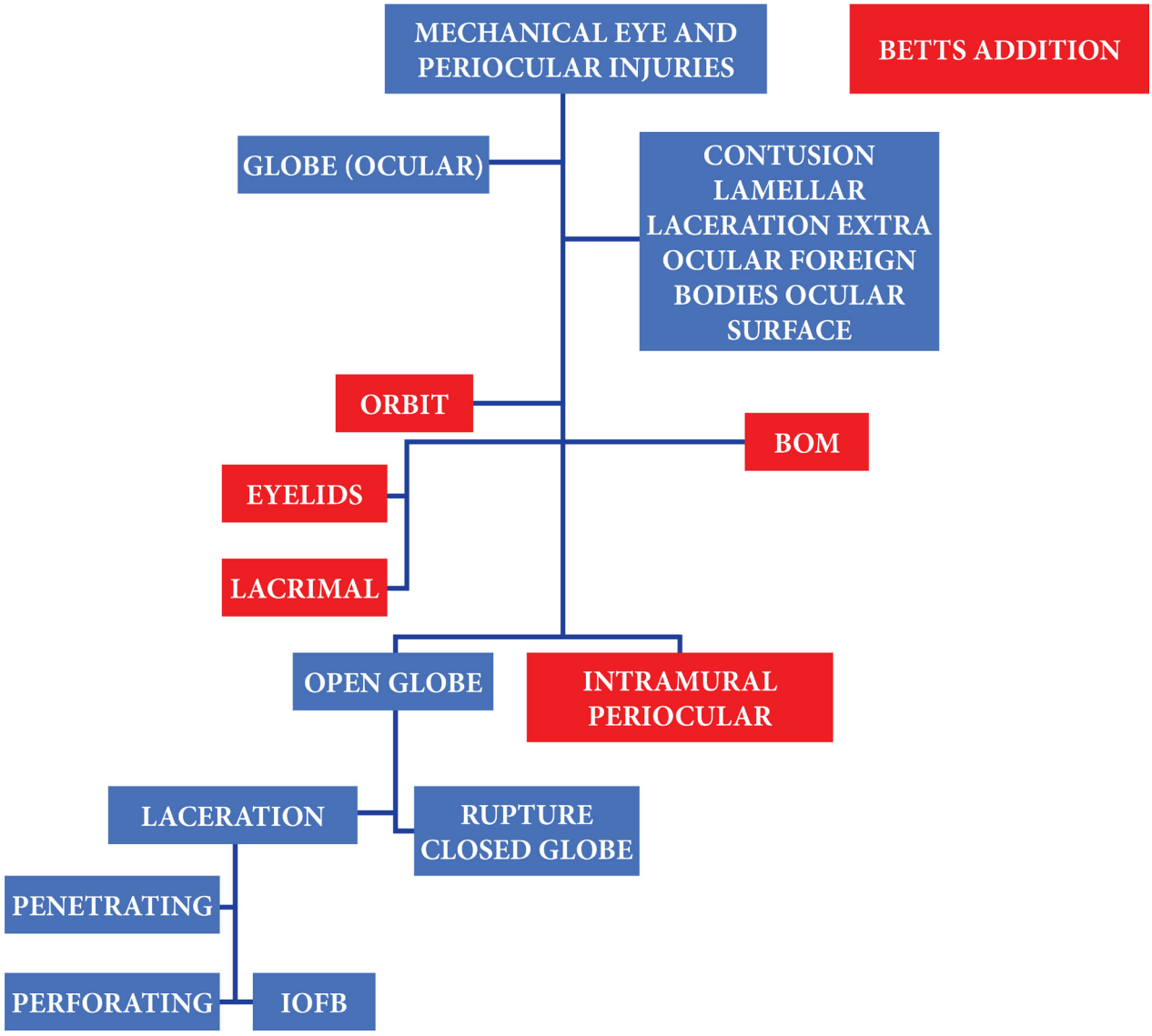

Figure 1: *Modified BETTS Classification.*

children surgeon may resort to single step procedure and perform lens extraction, intraocular lens implantation and if required anterior vitrectomy for optimal outcome. Primary IOL implantation not only prevents amblyopia but also synechia formation that can close the bag by the time secondary IOL implantation can be carried out.[62,63]

In adults where amblyopia is not a issue, the choice of surgery is governed by surgeon's own preferences and also to certain extent by the status of cataractous lens. But in children lens is soft and unimanual or bimanual aspiration or lensectomy either anterior or pars plana route may be used. In case of delayed presentation membranous cataract to be removed using vitrectomy. If anterior capsule is significantly disrupted and there is free floating lens matter in the anterior chamber, the surgeon may be justified in primary cataract extraction with or without IOL implantation (Figure 3). Eyes with lens vitreous admixture should be taken up for combined cataract extraction with

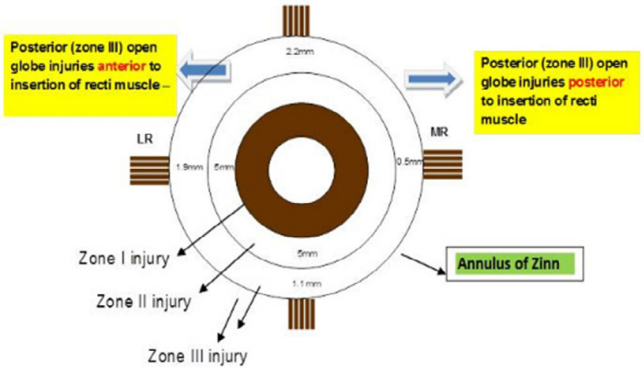

Figure 2: *Diagrammatic representation of extend of wound in relation to recti insertion.*

limited anterior vitrectomy and care should be taken to judiciously use vitrector and not aspirator while removing vitreous admixed in the ruptured lens matter (Figure 4). In the setting of additional injury to the posterior segment, early pars plana lensectomy and vitrectomy by a posterior

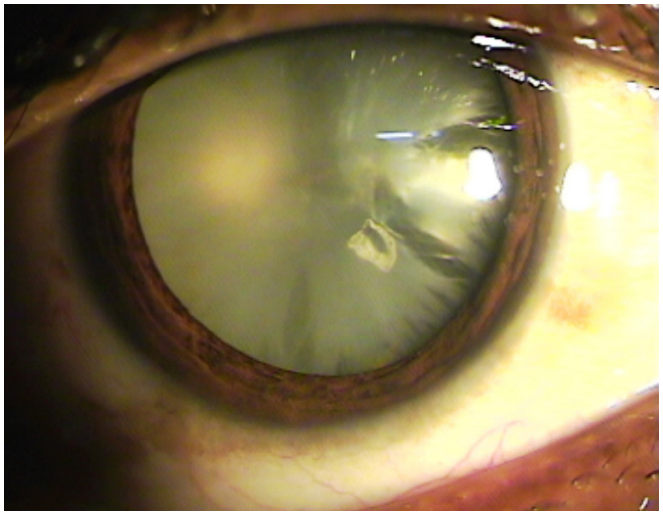

Figure 3: *Total cataract.*

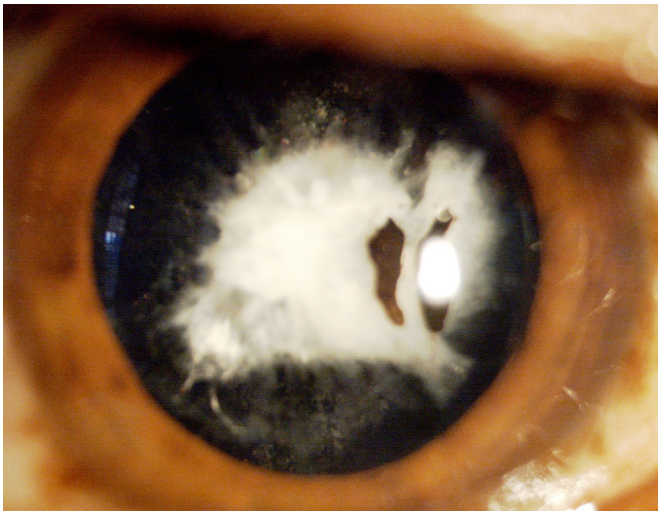

Figure 5: *Traumatic cataract with fusion of anterior and posterior capsule.*

segment specialist is warranted. In eyes with intact anterior capsule and total traumatic cataract, second sitting cataract extraction with IOL implantation should be best and safe approach for optimal visual outcome (Figure 5).[64]

Traumatic cataract management in toddlers and adolescents surgical anatomy of limbus and pars plana varies according to age[65,66] surgical techniques are significantly different in toddlers requires skills to manage pediatric eye.[63,64] IOL power calculation is also more complex in unilateral eye.[64] visual outcome is significantly better in children post amylogenic age> 5years.[66]

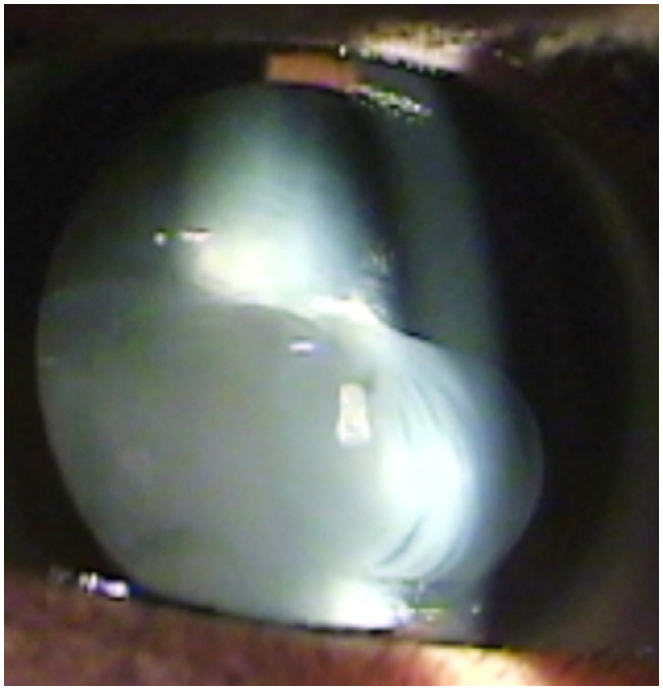

Figure 4: *Traumatic cataract with ruptured anterior capsule.*

Timing of presentation will define morphology and strategy for management.[64]

Timing of intervention early versus late surgery is matter of debate if cataract surgery is defer by 2-4 weeks visual acuity is significantly better.[68] Tabatabaei reported early versus late cataract surgery does not have significant difference in visual outcome.[69] Controversy exists over timing of cataract extraction and intraocular lens implantation. Arguments can be for both primary and secondary cataract extraction, we need to look at the crucial facts before making the decision. Cataract extraction along with primary wound repair may have distinct advantages such as controlling inflammation and possibility of raised intraocular pressure due to soft lens matter in anterior chamber.[70] Secondary advantages can be direct visualization of the posterior segment and optic nerve.[70] Similarly, in pediatric patients removal of media opacity may be crucial to prevent vision deprivation amblyopia. In patients with lens vitreous admixture, it's a potent stimulator for further proliferative vitreoretinopathy and can also result in traction on the retina, hence primary extraction of lens and vitreous is imperative in such patients. Remote advantage of primary lens removal is for patient's convenience and possibly cost effectiveness.[67-70]

Proponents of second sitting cataract extraction recommend good control of intraocular inflammation, good media clarity and stable wound before planning for traumatic cataract extraction.[70] Also, if there is adequate control of inflammation intraocular lens implantation at second stage cataract extraction may be associated with better outcome. Intraocular lens power calculation is also appropriate if the IOL implantation is planned for second sitting.[66,70]

IOL not implanted in toddlers less than 1.5 years, any eye

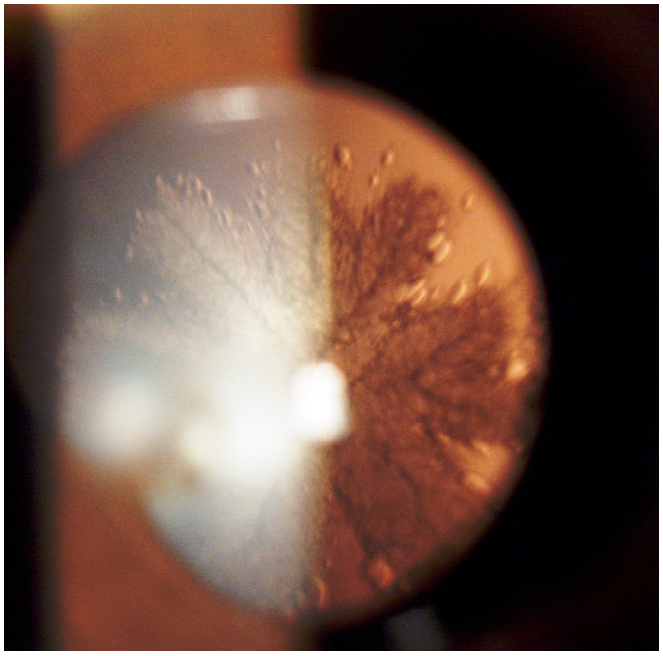

Figure 5: *Rosette Cataract.*

which has deficient zonules or any co existing posterior segment pathology.[65-67]

On the other hand, it may be difficult if not impossible to determine the correct IOL power prior to surgery (often the other eye serves as a guide); the inflammatory debris can settle on the IOL surface, and it may require postoperative YAG laser or even surgery to cleanse it; and last but not least, the edge of the IOL will interfere with the surgeon's visualization of the peripheral retina should subsequent PVR development necessitate vitrectomy.[66-68]

IOL power calculation is a complex problem for unilateral traumatic cataracts in children under 5 years of age because it impacts final outcome because of amblyopia and visual development.[63,68] In unilateral case making child emmetropic is important for development of binocular vision.[64] There are few studies comparing visual outcome amongst open and closed globe injuries visual outcome is better in closed globe injuries.[14,65] There is debate regarding single or multiple step surgeries advocated by different authors majority of studies suggested in multistep management[71-73] a case reported with primary scleral repair and scleral buckle.[74] Wherever possible, multistep procedure after control of inflammation and adequate corneal clarity and appropriate IOL power calculation should be adopted.[64,65]

Secondary lens implants considered in case of aphakia as unilateral aphakia is common cause of deep amblyopia[8,9] if it is planned aphakia because of age secondary implantation may be considered after age of 1.5 to 2 years. If sulcus fixated lens is to be used three piece lens is preferred to avoid secondary inflammation, in absence of support scleral fixated lenses may be used either suture fixated[73-75] or sclera supported glued lenses,[75] there can be specially designed endo endoscleral (scleral tuck lens) may be used, or iris supported posterior chamber lens may be used. Visual outcome is not significantly different by location of lens position.

In case of it is not only cataract surgery which will decide outcome ocular comorbidities are major factors.[64,65] Pre existing pathologies like congenital anomalies sensory nystagmus, Microphthalmos or colobomas may impact on outcome.

In summary, the vast majority of ophthalmologists who encounter a traumatic cataract have sufficient experience in lens extraction (and IOL implantation) in a non-traumatic setting. What every ophthalmologist must accept is that an injured lens requires many individualized, consciously made decisions regarding what to do when and how to achieve the best possible outcome.

Management of posterior segment ocular trauma

Many aspects of vitrectomy surgery for open-globe injuries remain controversial. The general areas include the role and timing of vitrectomy surgery, the use of prophylactic cryotherapy and scleral buckling, prophylactic use of antibiotics and routes of antibiotic administration,[76] show a clear benefit from a prophylactic treatment protocol, one approach might be to treat all open globe injuries with systemic (oral /intravenous) and topical antibiotics for a few days. Intravitreal antibiotics prophylaxis can be used selectively in eyes with contaminated injuries, long wound length, or delayed primary closure of the wound and after ruling our retinal detachment or suprachoroidal hemorrhage because such cases have an increased risk of endophthalmitis.[8,9]

Vitrectomy in patients with vitreous hemorrhage following surgical repair of open globe injury: Role of vitrectomy in eyes with scleral or corneoscleral laceration on presentation with a dense vitreous hemorrhage and no view of the retina is debated.[76,77] There is no evidence based review for role of observation versus vitrectomy which is not feasible in pediatric population. Mitra et al. recommended vitreoretinal intervention for eyes that have a significant vitreous hemorrhage after ruptured globe repair. Authors justified that the operation not only clears the visual axis, providing faster visual recovery, but it may also prevent late tractional retinal detachments.[76] In addition, the removal of vitreous hemorrhage from these eyes may uncover previously undetected retinal tears that could otherwise lead to rhegmatogenous retinal detachment.

Early vitrectomy is important for pediatric population to prevent amblyopia.

Timing of vitrectomy

Though there is agreement about many of the indications for the use of vitrectomy in open-globe injuries, the timing of this intervention remains highly controversial.[75-76] Most surgeons will agree that immediate vitrectomy is indicated for posttraumatic endophthalmitis or IOFB with high risk of infection, but timing of surgery with other scenarios is less clear.[75-76-2] Combined vitrectomy with primary wound repair or early vitrectomy at day 1-4 was technically more difficult because of increased incidence of vitreoretinal adhesions and absence of posterior vitreous detachment. Also in patients with corneoscleral laceration, there can be presence of corneal edema with or without traumatic cataract precluding visualization of posterior segment. Coleman showed that 65% of patients in his series achieved a visual acuity of 20/40 or better when operated on sooner than to 72 hours after injury, whereas those operated at later time points fared less well.[77] However, the percentage of patients in the early group with IOFBs or incarcerated vitreous without hemorrhage or retinal detachment was not specified.[77] Likewise, DeJuan et al.,[78] showed a trend toward better visual results with early vitrectomy, however there were higher proportion of IOFBs in the early vitrectomy group. Studies with vitrectomy done in the intermediate period have shown a trend toward better visual outcome with vitreous surgery after the acute period and sooner than 2 weeks after traumatic injury.[79-80] Vitrectomy done from 4 to 10 days or before 2 weeks result in uveal congestion that develops after trauma and result in uncontrollable intraoperative hemorrhage, making vitrectomy difficult or impossible to complete.[76-80] Delayed surgery after two weeks of primary wound repair also allows for spontaneous separation of the posterior hyaloid face, makes the vitrectomy less complex.[2-4] In addition, if there is a hemorrhagic choroidal detachment, delayed intervention can allow for liquefaction of the clot, enabling easier removal.[77-80] Media opacity secondary to traumatic hyphema, fibrinoid aqueous, or corneal edema, will clear in two - three weeks, and hence facilitate vitreoretinal surgery with much ease.[77-80] In eyes with no light perception, ancillary studies, such as echography, electroretinography and visual evoked potentials, can be obtained to help guide appropriate intervention. Dalma-Weiszhausz also showed a trend toward improvement with vitrectomy after 14 days. Numerous studies had shown no significant effect on outcome with regard to timing of vitrectomy.[81] These all argument to defer surgeries may not suitable for pediatric population as there is risk of amblyopia.[9]

Evaluation of the experimental and clinical data does not allow a definitive recommendation regarding the timing of intervention with vitreous surgery after ocular trauma. Given the heterogeneity of presentation in open-globe injuries, a large prospective randomized clinical trial for proactive management of eyes with posterior segment trauma would be necessary to adequately evaluate all potential risk factors and concerns.

Traumatic glaucoma is also one of the manifestation of ocular trauma Agrawal reported glaucoma in children following ocular trauma, Alamri reported a case report ghost cell glaucoma.[82,83]

Bai reported causes resulting in high IOP include intraocular bleeding, lens dislocation, phacoanaphylaxis, angle recession, and siderosis following ocular trauma.[84] Fang et al. studied profile of pediatric glaucoma patients in Shanghai traumatic glaucoma was the third most common subtype (n = 81, 11.03%).[85] Gadia studied current profile of secondary glaucomas 25% were between 0-20 years and amongst causes trauma 13%.[86] This review aims studied the demographical profile, presentation, management and outcome of traumatic glaucoma in children as well as the various factors associated with advanced glaucomatous changes[87] Osman reported high IOP levels occurred owing to the presence of unremoved lens particles in 11 patients (26.8%), inflammation in 6 patients (14.6%), and hyphema in 3 patients (7.3%)[88] Qiao reported the majority of traumatic glaucoma occurred in children between 10 and 15 years of age (n = 72, 56.25%).[89]

Schlote suggested mitomycin-augmented trabeculectomy is the surgical method of first choice in patients with open angle traumatic glaucoma. Transscleral cyclophotocoagulation represents the method of first choice in secondary angle closure glaucoma[90] Senthil, steroid-induced and traumatic glaucomas were the most common acquired glaucomas;[91] Sihota, clinically, the presence of increased pigmentation at the angle, elevated baseline IOP, hyphema, lens displacement, and angle recession of more than 180 degrees were significantly associated with the occurrence of chronic glaucoma after closed globe injury. On UBM findings, a wider angle and the absence of cyclodialysis were significant predictors for the subsequent development of traumatic glaucoma.[92]

Yadgarov reported implantation of a Ahmed or Baerveldt tube shunt provided successful control of IOP ipatients with medically uncontrollable traumatic glaucoma.[93]

Various management modalities reported varities of than drainage devices has been very successful for management of post traumatic glaucomas in children.[94-97]

Management of traumatic endophthalmitis

Post traumatic endophthalmitis: Not all clinicians agree with the routine use of intravitreal antibiotics in prophylaxis.[8,9] In patients with open globe injuries and traumatic endophthalmitis there is always a risk of associated retinal detachment of choroidal detachment. Preoperative B-scan is not routinely done in eyes with open globe injury and hence intravitreal injection can pose additional risk of injection going inadvertently into subretinal or suprachoroidal space. On the other hand, it is important to realize that no large randomized, prospective study explicitly has demonstrated a decrease in incidence of post-traumatic endophthalmitis with prophylactic antibiotics in eyes without IOFBs. For ruptured globes without IOFBs, until a prospective study[8,9] Al reported posttraumatic endophthalmitis (10% of open globe injuries). Important risk factors are late presentation and repair of open globe injuries, retained IOFB or injuries by contaminated object.[98] Bansal studied Pediatric posttraumatic endophthalmitis presents with great complexities and challenges arising due to delayed presentation, difficulty in eliciting an accurate history, or trauma with unusual and highly contaminated objects.[99]

Endophthalmitis Vitrectomy Study finding not applicable to traumatic endophthalmitis so strategies or management custom according to habitat and setting of injuries.[8,9]

Post trauma endophthalmitis is one of the important indication of destructive procedures in case of open globe injuries.[100]

Sympathetic ophthalmia

Biswas et al reported that sympathetic ophthalmia is a rare cause of bilateral granulomatous uveitis in children. Reported incidence of this clinical entity ranges from 0.2% to 0.5% following injury and 0.01% following intraocular surgery. Ocular surgical intervention has been found to be the most common cause of sympathetic ophthalmia in recent studies.[101]

Though majority of the cases occur within 1 year of insult or injury, the onset of sympathetic ophthalmia varies with a range of 10 days to 66 years. The cause of this clinical entity is not completely understood. Though rare, sympathetic ophthalmia is a dreaded cause of visual morbidity. Proper and rapid treatment, if not started early can lead to irreversible loss of vision. Sympathetic ophthalmia classically presents as bilateral panuveitis. Common findings are bilateral anterior granulomatous uveitis associated with mutton-fat KPs, moderate-to-severe vitritis, exudative retinal detachment, papillitis, and choroiditis. Sub-RPE yellowish white nodules mainly seen in peripheral retina are known as Dalen-Fuchs nodules and found in one-third patients of sympathetic ophthalmia. Corticosteroids remain the mainstay of treatment in such cases. Immunosuppressants like azathioprine and chlorambucil have been used in fulminant and recalcitrant cases.The role of enucleation, within 2 weeks of injury, is controversial, and with advent of newer immuno suppressives and better understanding of the disease process, it is rarely used as a management option. Marak et al. reported sympathetic ophthalmia in children.[101-4]

Post trauma strabismus is one of the manifestation ocular trauma. Most common cause of alteration in motility caused by orbital fracture.[105,106] Other cause is strabismus. Rosner reported approximately 30% of the patients with a medically based diagnosis of concussion exhibited esophoria at near[107] David reported poor vision because of media or posterior segment defect may result in strabismus.[108] Pojda, reported paralytic strabismus also resulted because of brain or orbital trauma.[109]

Direct damage Shah et al. reported direct damage to inferior rectus by metal object during work[110] and Voinea, L following direct injuries to muscle.[111]

Shah et al. reported the incidence of strabismus in cases of pediatric cataract was only 5%, was more common in the non-traumatic group.[112]

Adnexal Injuries

BETTS classification did not include periocular trauma but many studies reported peri ocular and adnexal trauma in pediatric population in various settings. Agrawal et al. reported inclusion in modified BETTS classification. Shah et al reported 7% associated with orbital/ocular adnexa injury out of total injuries. Chan reported serious eye and adnexal injuries from fireworks in Northern Ireland before with mean age 18 years.[113]

Chaudhry reported large number of lid adnexal and orbital injuries[114] Frimmel reported ype, severity, management and outcome of ocular and adnexal firework-related injuries where 52% were </=18 years[115] Gonnering, reported ocular adnexal injury and complications in orbital dog bites. Two-thirds were under 10 and over half under 5 years of age.[116] Shukla also included adnexal injuries in newer classification.[12] Yardley reported 60.7% cases had adnexal injuries in pediatric age group.[117] Yardley examined the current literature regarding the nature and severity of animal-inflicted ocular and adnexal injuries in children.[118]

Destructive procedures in children, indications of destructive procedure in case of open globe injuries mainly traumatic endohthalmitis or severly traumatized eye to avoid sympathetic ophthalmia which is very controversial Jiang reported The total number of trauma-related

eviscerations recorded in the past five years was 821 cases. The number of surgeries performed was almost constant each year (164 +/- 17 cases); 35% of the patients were less than ten years old at the time of the original ocular injury and 69% of them were male.[120] Children under 15 years constituted 25.1% of whom 9.3% were under 5 years and ocular injuries accounted for ocular 23.2%[1] Balta reported The most common cause of evisceration was ocular trauma (184 patients; 60.1%)[121] Dortzbach reported evisceration is procedure preferred for painful eyes and in selected instances of ocular trauma following discussion of the risk of sympathetic ophthalmia with the patient.[122] Adeoye reported trauma was the leading cause of eye removal (43.4%).[123]

Ainbinder reported hydroxyl appetite implant successfully for eviscerated eyes.[124] Arellano-Ganem reported ,porous polyethylene implant for ocular trauma cases in children.[125]

CONCLUSION

Pediatric ocular trauma is important and complex topic. Many new studies has helped to resolve these mysteries, this discussion might help to fix many issues. Many more multi centric evidence based research required to upgrade knowledge and reduce unnecessary burden on society.

Literature review

All the possible literature relevant to management of ocular trauma was searched on Cochrane data base for eyes and vision group, medline (1970-2011), EMBASE and metaRegister for clinical trials. It also used PUBMED central and ENDnote 9X also to search literature.

REFERENCES

1. Pieramici DJ, Sternber P, Aaberg TM. A system for classifying mechanical injuries of the eye (globe). Am J Ophthalmol 1997;123: 820-31.
2. Kuhn F, Maisiak R, Mann L, et al. The Ocular Trauma Score (OTS). Ophthalmol Clin N Am 2002;15: 163-5.
3. Unver YB, Acar N, Kapran Z, et al. Visual predictive value of the ocular trauma score in children. Br J Ophthalmol 2008; 92: 1122-4.
4. Hairston RJ, Maguire AM, Vitale S, et al. Morphometric analysis of pars plana development in humans. Retina 1997;17: 135-8.
5. Aiello AL, Tran VT, Rao NA. Postnatal development of the ciliary body and pars plana. A morphometric study in childhood. Arch Ophthalmol 1992; 110: 802-5.
6. Straatsma BR, Landers MB, Kreiger AE. The ora serrata in the adult human eye. Arch Ophthalmol 1968; 80: 3.
7. Kuhn F, Morris R, Witherspoon CD, et al. The Birmingham Eye Trauma Terminology system (BETT). J Fr Ophtalmol 2004; 27: 206-10.
8. Shah M, Shah S, Agrawal R, et al. Validation of a modifi ed Birmingham Eye Trauma Terminology classifi cation for mechanical eye injuries. Trauma 2017; Trauma 20:146040861771548
9. Agrawal R, Shah M, Mireskandari K, et al. Controversies in ocular trauma classifi cation and management: review. Int Ophthalmol 2013;33: 435-45.
10. Shah M, Shah S, Upadhyay P, et al. Controversies intraumatic cataract classifi cation and management: A review Can J Ophthalmol 2013; 0008-4182.
11. Shukla B., Agrawal D, Shukla D et al. Systematic analysis of ocular trauma by a new proposed ocular trauma classifi cation. Indian J Ophthalmol 2017; 65: 719-22.
12. Toh ZH, Agrawal S, Raje D, et al. International globe and adnexal trauma epidemiology study (IGATES): a report from central India on visual outcome in open globe injuries and correlation with ocular trauma score. Int Ophthalmol. 2020;40:2797-2806.
13. Shah M, Shah S, Khandekar R. Ocular injuries and visual status before and after their management in the tribal areas of Western India-A historical cohort study. Graefes Arch Clin Exp Ophthalmol 2008; 246:191–7.
14. Shah MA, Shah SM, Gosai SR, et al. Comparative study of visual outcome between open- and closed-globe injuries following surgical treatment of traumatic cataract in children. Eur J Ophthalmol 2018;28:406-11.
15. Shah SM, Shah MA, Singh R, et al. A prospective cohort study on the epidemiology of ocular trauma associated with closed-globe injuries in pediatric age group. Indian J Ophthalmol 2020;68:500-3.
16. Qayum S, Anjum R, Rather S. Epidemiological profi le of pediatric ocular trauma in a tertiary hospital of northern India. Chin J Traumatol . 2018;21:100-3.
17. Bućan K, Matas A, Lovrić JM, et al. Epidemiology of ocular trauma in children requiring hospital admission:a 16–year retrospective cohort study. J Glob Health 2017;7:010415.
18. Madan AH, Joshi RS, Wadekar PD. Ocular Trauma in Pediatric Age Group at a Tertiary Eye Care Center in Central Maharashtra, India. Clin Ophthalmol 2020:14 1003-9.
19. Puodžiuvienė E, Jokūbauskienė G, Vieversytė M, etal. A five-year retrospective study of the epidemiological characteristics and visual outcomes of pediatric ocular trauma BMC Ophthalmology 2018; 18:10.
20. Aldoais TM, Bamashmus MA, Aldubhani AN. Pediatric Ocular Trauma during Eid Festivities in Yemen. Korean J Ophthalmol 2020; 34: 187-91.
21. Batur M, Seven E, Akaltun MN et al.Epidemiology of Open Globe Injury in Children. J Craniofac Surg 2017; 28: 1976-81.
22. Boret C, Brehin C, Cortey C, et al. Pediatric ocular trauma: Characteristics and outcomes among a French cohort (2007-2016). Arch Pediatr 2020; 27: 128-34.
23. Bratton EM, Golas L, Wei LA, et al. Ophthalmic Manifestations of Facial Dog Bites in Children. Ophthalmic Plast Reconstr Surg. 2018;34:106-9.

24. Bućan K, Matas A, Lovric JM, et al. Epidemiology of ocular trauma in children requiring hospital admission: a 16-year retrospective cohort study. J Glob Health 2017;7:010415.

25. Ferguson RA, Sung J, McKelvie J. New Zealand childhood ocular trauma study: Analysis of 75 601 cases of ocular injury from 2007 to 2016. Clin Exp Ophthalmol 2019;47:718-25.

26. Knyazer B, Levy J, Rosen S, et al. Prognostic factors in posterior open globe injuries (zone-III injuries). Clin Exp Ophthalmol 2008; 36: 836-41.

27. Abrams GW, Kington RW. Falsely extinguished bright light fl ash electroretinogram. Its association with dense vitreous hemorrhage. Arch Ophthalmol 1984; 100: 1427-9.

28. Morris R, Kuhn F, Witherspoon CD Management of the opaque media eye with no light perception. In: Alfaro, DV, Liggett, PEeds. Vitreoretinal surgery of the injured eye. Lippincott Raven, Philadelphia 1999; 113-24

29. Shah M, Shah S, Agrawal R, et al. Visual Outcome of Severely Traumatized Eyes with No Light Perception. Ret Vit 2018; 27: 140-9.

30. Rabinowitz R, Yagev R, Shoham A. Comparison between clinical and ultrasound fi ndings in patients with vitreous hemorrhage. Eye 2004; 18: 253-6.

31. Dikci S, Yildirim Oİ, Firat M et al. Computed Tomography Diagnostic Abilities for Open-Globe Injuries in Pediatric Versus Adult Patients. Pediatr Emerg Care 2021;37:e100-e4.

32. Posarelli C, Sartini F, Casini G, et al. What Is the Impact of Intraoperative Microscope-Integrated OCT in Ophthalmic Surgery? Relevant Applications and Outcomes. A Systematic Review. J Clin Med. 2020; 9: 1682.

33. Lim SH. Clinical Applications of Anterior Segment Optical Coherence Tomography J Ophthalmol. 2015; 2015: 605729.

34. Celebi AC, Kilavuzoglu AE, Altiparmak UE, et al. The role of anterior segment optical coherence tomography in the management of an intra-corneal foreign body Springer plus. 2016; 5: 1559.

35. Cauduro RS, Ferraz CA, Morales MSA, et al. Application of Anterior Segment Optical Coherence Tomography in Pediatric Ophthalmology J Ophthalmol. 2012; 2012: 313120.

36. Acar U, Tok OY, Acar DE, et al. A new ocular trauma score in pediatric penetrating eye injuries. Eye 2011; 25: 370-4.

37. Shah MA, Agrawal R, Shreya RT. Et al. Pediatric ocular trauma score as a prognostic tool in the management of pediatric traumatic cataracts Graefes Arch Clin Exp Ophthalmol 2017;255:1027–36

38. Shah MA, Shah AM, Applewar A, et al. Ocular Trauma Score as a predictor of fi nal visual outcomes in traumatic cataract cases in pediatric patients J Cataract Refract Surg 2012; 38:959-65.

39. Shah MA, Shah SM, Applewar A, et al. Ocular Trauma Score: A Useful Predictorof Visual Outcome at Six Weeks in Patients with Traumatic Cataract. Ophthalmology 2012;119:1336-41.

40. Shah M, Sundar G, Shah S. Ocular Trauma Score revisited – Making sense of it all Latin American Journal of Ophthalmology, 2019; 2.

41. Read SP, Cavuoto KM. Traumatic open globe injury in young pediatric patients: characterization of a novel prognostic score. J AAPOS 2016; 20:141-4.

42. Fuller DG. Traumatic choroidal rupture in a six-yearold. Optom Vis Sci 1989; 66: 66-9.

43. Goldman D R, Vora RA, Reichel E. Traumatic choroidal rupture with submacular hemorrhage treated with pneumatic displacement. Retina 2014; 34: 1258-60.

44. Piermarocchi S, Benetti E, Fracasso G. Intravitreal bevacizumab for posttraumatic choroidal neovascularization in a child. J AAPOS 2011; 15: 314-6.

45. Rishi P, Shroff D, Rishi E. Intravitreal bevacizumab in the management of posttraumatic choroidal neovascular membrane. Retin Cases Brief Rep 2008; 2: 236-8.

46. Secretan, M., M. Sickenberg, et al. "Morphometric characteristics of traumatic choroidal ruptures associated with neovascularization." Retina 1998:18: 62-6.

47. Bosch-Valero J, Mateo J, Núñez-Benito E et al. Spontaneous closure of full thickness traumatic macular holes. Arch Soc Esp Oftalmol 2008;83: 325-7.

48. Bor'i A, Al-Aswad MA, Saad AA, et al. Pars Plana Vitrectomy with Internal Limiting Membrane Peeling in Traumatic Macular Hole: 14% Perfluoropropane (C3F8) versus Silicone Oil Tamponade. J Ophthalmol 2017: 3917696.

49. Brennan N, Reekie I, Khawaja AP, et al. Vitrectomy, Inner Limiting Membrane Peel, and Gas Tamponade in the Management of Traumatic Paediatric Macular Holes: A Case Series of 13 Patients. Ophthalmologica 2017; 238: 119-23.

50. Chen H, Chen W, Zheng K, et al. Prediction of spontaneous closure of traumatic macular hole with spectral domain optical coherence tomography. Sci Rep 2015; 5: 12343.

51. Stepankova J, Dotrelova D. Treatment of pediatric traumatic macular holes. Cesk Slov Oftalmol 2015;71: 30-6.

52. Tsui, I., B. N. Campolattaro, et al. "Progression of traumatic lamellar macular hole to full-thickness macular hole and retinal detachment in a 3-year-old child." Retin Cases Brief Rep 2010: 4: 25-7.

53. Wu W C, Drenser KA, Trese MT, et al. Pediatric traumatic macular hole: results of autologous plasmin enzyme-assisted vitrectomy. Am J Ophthalmol 2007; 144: 668-72.

54. Shah M, Shah S, Gunay R et al. Comparative Study of Visual Outcomes Following Vitrectomy for Nucleus Drop Caused by Various etiologies. Acta Scientific Ophthalmology 3.8 (2020): 41-7.

55. Altintas L, Altintas O, Yuksel N, et al. Pattern of open eye injuries in northwest Turkey: a retrospective study. Ulus Travma Acil Cerrahi Dergisi 2011; 17: 334-9.

56. Andreoli MT, Andreoli CM. Geriatric traumatic open globe injuries. Ophthalmology 2011; 118: 156-9.

57. Fujikawa A, Mohamed YH, Kinoshita H, et al. Visual outcomes and prognostic factors in open-globe injuries. BMC Ophthalmol 2018; 18: 138.

58. Lesniak S P, Bauza A, Son JH, et al. Twelve-year review of pediatric traumatic open globe injuries in an urban U.S. population. J Pediatr Ophthalmol Strabismus 2012;49: 73-9.

59. Ustaoglu M, Karapapak M, Tiryaki S, et al. Demographic characteristics and visual outcomes of open globe injuries in a tertiary hospital in Istanbul, Turkey. Eur J Trauma Emerg Surg 2020; 46: 549-56.

60. Mehul, A. Shah, kalyani JD, et al. Innovative methods of Anesthesia for eye surgery in children. J Anesth Surg 2015;2: 1-3.

61. Shah MA, Shah SM, Janak D, et al. Optimum Utilization of Regional Anaesthesia for Eye Surgery in Children. Journal of Ocular Diseases and Therapeutics, 2014, 2, 64-7.

62. Shah MA, Shah SM, Khushboo A, et al. Factors Affecting Visual Outcome Following Surgical Treatment of Cataracts in Children. Open Journal of Ophthalmology, 2012, 2, 131-9.

63. Shah MA, Shah SM, Chaudhry AH, et al. Traumatic cataracts in children: Visual outcome. World J Ophthalmol.2015; 5: 80-5.

64. Shah MA, Shah SM, Shah SB, et al. Morphology of traumatic cataract: does it play a role in fi nal visual outcome? BMJ Open 2011; 1: e000060.

65. Mehul Shah, Shah S, Upadhyay PKR, et al. Controversies in traumatic cataract classification and management: A review. Canadian J Ophthalmol 2013; 48:251-8.

66. Shah M, Shah S, Shah AH, et al. Cataract How Important Is Age of Intervention? Int J Ophthalmol Eye Res, 02, 24-29

67. Shah MA, Shah SM, Krunal D, et al. Maximizing the visual outcome in traumatic cataract cases: The value of a primary posterior capsulotomy and anterior vitrectomy. Indian J Ophthalmol. 2014 ;62:1077-81.

68. Mehul A. Shah, Shreya M. Shah, Shashank B. Shah, Utsav A. Patel Effect of interval between time of injury and timing of intervention on fi nal visual outcome in cases of traumatic cataract Eur J Ophthalmol 2011; 00: 000-000

69. Tabatabaei SA, Rajabi MB, Tabatabaei SM, et al. Early versus late traumatic cataract surgery and intraocular lens implantation Eye 2017; 31, 1199- 204.

70. Kuhn F. Traumatic cataract: what, when, how. Graefes Arch Clin Exp Ophthalmol 2010; 248:1221-3.

71. Ceklic L, Latinovic S, Aljoscha S, et al. Management and treatment of bizarre open globe trauma in three steps: a case report Int J Ophthalmol. 2011; 4: 218-219.

72. Arroyo JG, Postel EA, Stone T, et al. A matched study of primary scleral buckle placement during repair of posterior segment open globe injuries. Br J Ophthalmol. 2003; 87: 75–8.

73. Kelkar A, Shah R, Vasavda V, et al. Primary iris claw IOL retrofi xation with intravitreal triamcinolone acetonide in cases of inadequate capsular support. Int Ophthalmol 2018;38:111- 7.

74. Agarwal A, jacob S, Agarwal A, et al. Glued intraocular lens scaffolding to create an artifi cial posterior capsule for nucleus removal in eyes with posterior capsule tear and insuffi cient iris and sulcus support. J Cataract Refract Surg 2013;39:326-33.

75. Farrahi F, Feghhi M, Haghi F. Iris Claw versus Scleral Fixation Intraocular Lens Implantation during Pars Plana Vitrectomy. J Ophthalmic Vis Res 2012;7:118-24.

76. Mittra RA, Mieler WF. Controversies in the management of open-globe injuries involving the posterior segment. Surv Ophthalmol 1999; 44: 215-25.

77. Spalding SC, Sternberg P. Controversies in the management of posterior segment ocular trauma. Retina 1990; 10: S76-S82

78. Essex RW, Yi Q, Charles PG. Post-traumatic endophthalmitis. Ophthalmology 2004; 111: 2015-22.

79. De Juan E, Sternberg P, Michels RG. Timing of vitrectomy after penetrating ocular injuries. Ophthalmology 1984; 91: 1072-4

80. Mieler WF, Mittra RA. The role and timing of pars plana vitrectomy in penetrating ocular trauma. Arch Ophthalmol 1997; 115: 1191-2.

81. Dalma-Weiszhausz, J, Quiroz-Mercado H, Morales-Cantón V, et al. Vitrectomy for ocular trauma: a question of timing?. Eur J Ophthalmol 1996; 6: 460- 3.

82. Agrawal P, Shah P. Long-term outcomes following the surgical repair of traumatic cyclodialysis clefts. Eye (Lond) 2013; 27: 1347-52.

83. Alamri, A., H. Alkatan, Aljadaan I. Traumatic Ghost Cell Glaucoma with Successful Resolution of Corneal Blood Staining Following Pars Plana Vitrectomy. Middle East Afr J Ophthalmol 2016; 23: 271-3.

84. Bai HQ, Yao L, Wang DB, et al. Causes and treatments of traumatic secondary glaucoma. Eur J Ophthalmol 2009;19: 201-6.

85. Fang Y, Long Q, Guo W, et al. Profi le of pediatric glaucoma patients in Shanghai Eye, Ear, Nose and Throat Hospital. Chin Med J (Engl) 2014; 127: 1429-33.

86. Gadia R, Sihota R, Dada T, et al. Current profi le of secondary glaucomas. Indian J Ophthalmol 2008;56: 285-9.

87. Kaur S, Kaushik S, Pandav SS. Traumatic Glaucoma in Children. J Curr Glaucoma Pract 2014; 8: 58-62.

88. Osman EA, Mousa A, Al-Mansouri SM, et al. Glaucoma After Openglobe Injury at a Tertiary Care University Hospital: Cumulative Causes and Management. J Glaucoma 2016; 25: e170-4.

89. Qiao CY, Wang LH, Tang X, et al. Epidemiology of hospitalized pediatric glaucoma patients in Beijing Tongren Hospital. Chin Med J (Engl) 2009;122: 1162-6.

90. Schlote T, Rohrbach M. Traumatic glaucoma--a survey. Klin Monbl Augenheilkd 2005; 222: 772-82.

91. Senthil S, Badakere S, Ganesh J, et al. Profile of childhood glaucoma at a tertiary center in South India. Indian J Ophthalmol 2019; 67: 358-65.

92. Sihota R, Kumar S, Gupta V, et al. Early predictors of traumatic glaucoma after closed globe injury: trabecular pigmentation, widened angle recess, and higher baseline intraocular pressure. Arch Ophthalmol 2008; 126: 921-6.

93. Yadgarov A, Liu D, Crane ES, et al. Surgical Outcomes of Ahmed or Baerveldt Tube Shunt Implantation for medically

Uncontrolled Traumatic Glaucoma. J Curr Glaucoma Pract 2017; 11: 16-21.

94. Das J,Bhomaj S, Chaudhuri Z, et al. Profile of glaucoma in a major eye hospital in north India. Indian J Ophthalmol 2001; 49: 25-30.

95. Mokbel TH, El Hefney EM, Hagras SM et al. Childhood glaucoma profi le in Dakahelia, Egypt: a retrospective study. Int J Ophthalmol 2018; 11: 674-80.

96. Pandey P, Sung VC. Gonioaspiration for refractory glaucoma secondary to traumatic hyphema in patients with sickle cell trait. Ophthalmic Surg Lasers Imaging 2010; 41: 386-9.

97. Razeghinejad MR. Comment on internal cyclopexy for complicated traumatic cyclodialysis cleft. Acta Ophthalmol 2018; 96: e1046.

98. Al Wadeai EA, Osman AA, Macky TA, et al. Epidemiological Features of Pediatric Ocular Trauma in Egypt. J Ophthalmol 2016: 7874084.

99. Bansal P, Venkatesh P, Sharma Y. Posttraumatic Endophthalmitis in children: Epidemiology, Diagnosis, Management, and Prognosis. Semin Ophthalmol 2018; 33: 284-92.

100. Jiang Z, Yang Y, Li Y, et al. Risk Factors for TraumaRelated Eviscerations: Analysis of 821 Cases. J Ophthalmol 2019; 6198368.

101. Majumder PD, Biswas J. Pediatric uveitis: An update Oman J Ophthalmol. 2013; 6: 140– 50.

102. Kim JB, Jeroudi A, Sheil T, et al. Adalimumab for Pediatric Sympathetic Ophthalmia. JAMA Ophthalmol. 2014; 132: 1022–4.

103. Yeung IYL, Popp NA, Chan CC. The Role of Gender in Uveitis and Ocular Infl ammation. Int Ophthalmol Clin. 2015; 55: 111–131.

104. Cecil E. Shaw S. Sympathetic Ophtalmia Br Med J. 1898; 1: 1580–3.

105. Arrico L, Migliorini R, Bianchini D, et al. Ocular motility alterations in orbital fractures: pre-post evaluation in maxillofacial surgical treatment. G Chir 2018; 39: 363-7.

106. Rosner MS, Feinberg DL, Doble JE, et al. Treatment of vertical heterophoria ameliorates persistent post-concussive symptoms: A retrospective analysis utilizing a multi-faceted assessment battery. Brain Inj 2016; 30: 311-7.

107. Carroll SC, Ng SGJ. Outcomes of orbital blowout fracture surgery in children and adolescents. Br J Ophthalmol 2010; 94: 736-9.

108. David R, Davelman J, Mechoulam H, et al. Strabismus developing after unilateral and bilateral cataract surgery in children. Eye (Lond) 2016; 30: 1210-4.

109. Pojda SM. A case of post-traumatic paralytic convergent strabismus treated surgically with subsequent return of binocular vision. Klin Oczna 1984; 86: 445-6.

110. Shah AM , Shah MA, Prerna D, et al. Successful repair of injury to the eyelid, lacrimal passage,and extraocular muscle. GMS Ophthalmology Cases 2016,6, ISSN 2193-1496.

111. Voinea L, Samson M, Iliescu M. The loss of a right muscle in the orbit intra- or postoperatively. Oftalmologia 1996; 40: 120-4.

112. Shah AM, Shah MA, Pramod R, et al. Strabismus in Cases of Cataract in Pediatric Age Group. Open Journal of Ophthalmology, 2013, 3, 19-23.

113. Chan WC, Knox FA, McGinnity FG, et al. Serious eye and adnexal injuries from fi reworks in Northern Ireland before and after lifting of the fi rework ban--an ophthalmology unit's experience. Int Ophthalmol 2004; 25: 167-9.

114. Chaudhry IA, Al-Sharif AM, Shamsi FA et al. Severe ocular injuries from pointed door handles in children. Ophthalmology 2005;112: 1834-7.

115. Cao H, Li L, Zhang M. Epidemiology of patients hospitalized for ocular trauma in the Chaoshan region of China, 2001-2010. PLoS One 2012; 7: e48377.

116. Frimmel S, de Faber JT, Wubbels WJ, et al. Type, severity, management and outcome of ocular and adnexal fi reworkrelated injuries: the Rotterdam experience. Acta Ophthalmol 2018; 96: 607-15.

117. Gonnering RS. Ocular adnexal injury and complications in orbital dog bites. Ophthalmic Plast Reconstr Surg 1987; 3: 231-5.

118. Yardley AE, Hoskin AK, Hanman K, et al. Paediatric ocular and adnexal injuries requiring hospitalisation in Western Australia. Clin Exp Optom 2017; 100: 227-33.

119. Yardley AM, Hoskin AK, Hanman K, et al. Animal-inflicted ocular and adnexal injuries in children: A systematic review. Surv Ophthalmol 2015; 60: 536-46.

120. Jiang Z, Yang Y, Lİ Y, et al. Risk Factors for TraumaRelated Eviscerations: Analysis of 821 Cases. J Ophthalmol 2019: 6198368.

121. Gyasi ME, Amoaku WM, Adjuik M. Causes and incidence of destructive eye procedures in north-eastern ghana. Ghana Med J 2009;43:122-6.

122. Balta O, Acar U, Kocaoglu FA, et al. Review of 306 evisceration surgeries performed between 2005 and 2013. Turk J Med Sci 2016; 46: 463-7.

123. Dortzbach RK, Woog JJ. Choice of procedure. Enucleation, evisceration, or prosthetic fi tting over globes. Ophthalmology 1985; 92: 1249-55.

124. Adeoye AO, Onakpoya OH. Indication for eye removal in Ile-Ife, Nigeria. Afr J Med Med Sci 2007; 36: 371-5.

125. Ainbinder DJ, Haik BG. Tellado M. Hydroxyapatite orbital implant abscess: histopathologic correlation of an infected implant following evisceration. Ophthalmic Plast Reconstr Surg 1994; 10: 267-70.