Chapter 22

OCULAR TRAUMA

Isabella Cordeiro Barone
Vitória Teixeira Corrêa
Laura Zawaski Paim
Wellison Felipe Correia
Pedro Henrique Taddei
Bianca Maciel Torres Simões
Ana Paula Marques
Laura Carolina Andreo Gonçalves Kalbermatter
Lisa Mell Machado Russo
Nathan Augusto Muller
Luisa Gaudio Berardinelli Bernabé
Karoline Gomes Muniz

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Isabella Cordeiro Barone
Universidade Santo Amaro (UNISA)
São Paulo - São Paulo

Vitória Teixeira Corrêa
Faculdade Ciências Médicas de Minas Gerais
Belo Horizonte - Minas Gerais

Laura Zawaski Paim
Centro Universitário de Várzea Grande (UNIVAG)
Várzea Grande - Mato Grosso

Wellison Felipe Correia
Universidade do Oeste de Santa Catarina (UNOESC)
Joaçaba - Santa Catarina

Pedro Henrique Taddei
Universidade Vila Velha (UVV)
Vila Velha - Espírito Santo

Bianca Maciel Torres Simões
Centro Universitário Maurício de Nassau (UNINASSAU)
Cacoal - RO

Ana Paula Marques
Universidade do Oeste Paulista (UNOESTE)
Jaú - SP

Laura Carolina Andreo Gonçalves Kalbermatter
Centro Universitário Max Plank (UNIMAX)
Indaiatuba - SP

Lisa Mell Machado Russo
Universidade Nilton Lins (UNL)
Manaus - Amazonas

Nathan Augusto Muller
Universidade Franciscana (UFN)
Santa Maria - RS

Luisa Gaudio Berardinelli Bernabé
Faculdade Multivix de Vitória
Vitória - ES

Karoline Gomes Muniz
Faculdade Multivix de Vitória
Vitória - ES

Ocular trauma is a global public health issue with significant impacts on patients' quality of life. Structural changes in the eye due to trauma can lead to severe consequences, including permanent visual impairment. According to the World Health Organization (WHO), approximately 55 million people seek medical attention due to ocular injuries annually, and more than 75% of those affected become blind in one eye (Pouchain *et al.*, 2020; Jayme *et al.*, 2023; Balakrishnan *et al.*, 2020). The incidence of ophthalmic emergencies is higher among young men aged 20 to 40 years due to greater exposure to hazardous work environments. Ocular trauma is also common in childhood and adolescence, being a significant concern in pediatric ophthalmic care (Guevara, 2024).

Orbital anatomy, including the orbital floor composed of the maxillary, zygomatic, and palatine bones, and the lamina papyracea, is frequently affected in orbital traumas (Lozada, Cleveland, Smith, 2019). Ocular traumas can be caused by physical, chemical, or electrical agents and are classified into open and closed traumas. Closed trauma, more common, results from contusions and collisions, while open trauma involves cuts or perforations of the eyeball, posing an immediate risk of infection (Gomes; Castro e Silva; Ribeiro, 2019). Open globe injuries are classified into anatomical zones, with initial treatment focusing on watertight wound closure to allow healing and preparation for future surgeries (Razeghinejad *et al.*, 2020).

The initial diagnosis of ocular trauma involves a comprehensive evaluation, including visual acuity tests, pupillary reaction, intraocular pressure, and visual field tests (Gomes; Castro e Silva; Ribeiro, 2019). Advanced techniques like Optical Coherence Tomography (SD-OCT) and Fundus Autofluorescence (FAF) are used to assess retinal damage and visual prognosis (Mahesh *et al.*, 2019). Computed tomography (CT) is preferred for evaluating orbital fractures and bone injuries due to its high resolution and speed. B-scan ultrasound and Ultrasonic Biomicroscopy (UBM) are effective in detecting lesions in the posterior and anterior segments, respectively (Gomes; Castro e Silva; Ribeiro, 2019). Magnetic resonance imaging (MRI) is useful for detailed visualization of orbital structures, although contraindicated in cases of magnetic foreign bodies (Mahesh *et al.*, 2019).

Preventing ocular traumas is crucial, as recurrence is three times more likely after the first incident (Guevara, 2024). Public awareness measures on the importance of using personal protective equipment (PPE) and seeking immediate medical attention are essential. Additionally, it is vital that emergency physicians are adequately trained to handle ophthalmic emergencies, improving patient prognosis and avoiding irreversible damage (Jayme *et al.*, 2023). Detailed anatomical assessment through CT is indispensable for diagnosing intracranial injuries resulting from facial fractures, and early detection of these injuries can significantly reduce patient morbidity (Balakrishnan *et al.*, 2020).

EPIDEMIOLOGY

Ocular trauma is frequently encountered in ophthalmic emergencies, with higher incidence among young men, particularly those aged 20 to 40 years (Guevara, 2024; Cheung *et al.*., 2014). The main causes include workplace accidents in construction and agriculture, as well as inadequate care during childhood and adolescence (Guevara, 2024).

The incidence tends to be higher in urban areas due to exposure to risky activities and traffic accidents (Cheung *et al.*, 2014).

In the United States, ophthalmic emergencies account for about 3% of emergency department visits. In Brazil, this percentage is significantly higher, representing 13.6% of total admissions (Jayme *et al.*, 2023). Ocular trauma is the leading cause of unilateral blindness in the United States, affecting about 40,000 of the 60,000 patients who suffer ocular injuries annually. Men have a higher incidence compared to women due to greater exposure to high-risk work environments, such as agriculture and construction. The prevalence is estimated at 42.5% in young adults aged 20 to 40 years (Gomes; Castro e Silva; Ribeiro, 2019).

Historically, the incidence of ocular trauma has shown significant variations, with an increase in severe injuries between 1990 and 2010, especially in conflict areas and intensive industries (Cheung *et al.*, 2014). In Brazil, ocular traumas are common causes of emergency care, with a prevalence of diseases such as conjunctivitis and corneal abrasion (Guevara, 2024). Recently, awareness campaigns and improvements in medical care have contributed to a reduction in the incidence rate of severe traumas (Cheung *et al.*, 2014).

Ocular trauma should be prioritized in emergency care as it can lead to poor prognosis, such as total vision loss. However, most physicians attending these situations are not specialists (Jayme *et al.*, 2023). A survey pointed out that a general practitioner should be able to resolve 69% of ophthalmic emergency cases, but for good effectiveness, this number should be above 70%. Unfortunately, most hospitals present percentages below this average. About 93% of on-call physicians do not feel confident in handling ophthalmic patients (Jayme *et al.*, 2023).

Risk factors for ocular traumas include exposure to hazardous work environments, such as construction and agriculture, especially among adult men (Guevara, 2024; Cheung *et al.*, 2014). In childhood and adolescence, inadequate care increases susceptibility to traumas (Guevara, 2024). Additionally, behavioral factors, such as not using protective equipment, and genetic predispositions are also significant (Cheung *et al.*, 2014). Falls and physical assaults are the main causes of ocular traumas, commonly involving direct impact with objects and penetrating injuries.

The use of Personal Protective Equipment (PPE), combined with immediate medical attention in case of an accident, is crucial for a better patient prognosis. Statistical data reveal that 58% of patients attended in ophthalmic emergencies are men, with a high morbidity rate, often resulting in partial or total vision loss (Guevara, 2024; Cheung *et al.*, 2014). In a study conducted in 2016-2017, 6,483 patients were attended in the ophthalmic emergency unit, indicating the need for improvements in initial care, frequently provided by non-specialist physicians (Guevara, 2024). The mortality rate is low, but a rapid and effective medical response is crucial for survival and reduction of severe complications (Cheung *et al.*, 2014).

DIAGNOSIS

Early diagnosis in ocular trauma situations is extremely important because, in addition to improving the prognosis and relieving the discomfort caused by the trauma, quick identification can prevent serious complications and permanent vision damage. Some conditions are diagnosed only with imaging exams, however, any initial conduct in cases of ocular trauma must begin with a complete clinical evaluation, including visual acuity, tests for the presence of a relative afferent pupillary defect, evaluation of the anterior segment, and when possible, evaluation of the posterior segment of the eyeball (Balakrishnan *et al.*, 2020).

The signs and symptoms of ocular trauma vary according to the mechanism of the injury, highlighting the importance of evaluating the time elapsed since the trauma, and whether the injury was penetrating or resulted from a chemical burn. In the latter case, it is essential to obtain a detailed history, including the specific type of chemical compound involved, the time between exposure and irrigation, the duration and type of irrigation performed, and whether there was any eye protection, as these factors determine the severity, prognosis, and treatment (Logothetis; Leikin and Patrianakos, 2014).

In the evaluation of patients with corneal abrasion, the focus should be on evidence of penetrating trauma, decreased visual acuity, and signs of infection. These patients generally present with acute pain, photophobia, tearing, discomfort when blinking, and a foreign body sensation. In cases of hyphema, understanding the force, speed, type, and direction of the injury is crucial to facilitate more effective treatment. The clinic of traumatic iritis tends to include dull or aching pain, photophobia, decreased vision, and tearing, occurring within three days after the trauma. There may also be changes in intraocular pressure, mydriasis, miosis, conjunctival injection around the limbus, decreased vision, and the presence of floaters (Logothetis; Leikin and Patrianakos, 2014).

Patients with hyphema should pay attention to the use of anticoagulants such as aspirin, warfarin, clopidogrel, or non-steroidal anti-inflammatory drugs (NSAIDs). Additionally, the patient should be questioned about the presence of sickle cell disease and coagulopathies, as these conditions can influence the management and prognosis of ocular trauma (Logothetis; Leikin and Patrianakos, 2014). It is important to note that optic nerve injury may not be detected in the context of bilateral optic nerve injuries. Non-reactive pupils, in cases of traumatic brain injury, coma, or elevated intracranial pressure, make it difficult to assess a relative afferent pupillary defect (Balakrishnan *et al.*, 2020). If there is concern about a vascular injury affecting the orbit, such as a carotid-cavernous fistula, a computed tomography angiography (CTA) of the head may be indicated (Balakrishnan *et al.*, 2020).

The initial assessment of ocular trauma is based on a thorough evaluation of the patient, with special attention to the face, looking for signs of superficial wounds, penetrating injuries, avulsed tissues, or absence thereof. The physical examination should include an assessment of the eyes, eyelids, lacrimal system, and orbit (Ko *et al.*, 2021).

For open globe traumas, the initial examination should include an evaluation of visual acuity, inspection of the anterior chamber, performing the Seidel test (when indicated), and a detailed visual inspection that can assist in deciding to perform an examination under anesthesia. Other diagnostic modalities that may be necessary include the use of computed tomography (CT). In the evaluation of patients with closed globe injury, it is essential first to rule out an open globe injury. As in open globe injuries, a detailed ocular examination, including visual acuity verification, is crucial. Although the slit lamp generally offers the best details, in patients who cannot use it, alternative methods should be considered. In young children, a portable slit lamp may be used; however, to avoid the lower part of the device pressing against the child's chest, the device can be turned upside down (Miller, 2017).

The sensitivity of orbital radiographs for fractures varies between 64% and 78%, being mainly used for detecting metallic foreign bodies in the orbit (Balakrishnan *et al.*, 2020). Non-contrast CT of the orbits is preferred for initial investigation, as it is widely available, offers high resolution, and can be performed quickly (Balakrishnan *et al.*, 2020). CT is widely used in orbital trauma cases, and 1.5 to 2 mm cuts should be made in axial and coronal planes (Gomes; Castro e Silva and Ribeiro, 2019).

B-scan ultrasonography is especially useful in detecting intraorbital and intraocular damage. Although CT is superior to ultrasound for locating foreign bodies, ultrasonography is still employed in cases of retained intraocular foreign bodies, posterior segment evaluation in closed globe injuries with opacification, detection of hidden perforations in open globe injuries, iatrogenic globe injuries, and sequelae of acute penetrating trauma (Mahesh *et al.*, 2019).

X-rays are mainly used to diagnose fractures and locate foreign bodies (Gomes; Castro e Silva; Ribeiro, 2019). The full-field electroretinogram (ERG) is indicated when the patient's eyes have no light perception, being crucial for assessing the vitality of photoreceptor function. On the other hand, the multifocal ERG detects areas of the retina affected by trauma (Gomes; Castro e Silva; Ribeiro, 2019).

Magnetic resonance imaging (MRI) is not recommended for the initial evaluation of trauma and is contraindicated in cases of suspected metallic foreign bodies. However, MRI offers superior delineation of intraorbital and orbitocranial hemorrhages associated with foreign bodies and hematomas (Mahesh *et al.*, 2019). Fundus autofluorescence is used to assess the integrity of the retinal pigment epithelium in closed traumas, being a useful alternative when fluorescein fundus angiography is contraindicated. Choroidal ruptures can be visualized in FAF, and in cases of subretinal hemorrhage and Purtscher's retinopathy, the image appears hypoautofluorescent (Mahesh *et al.*, 2019). Additionally, spectral-domain optical coherence tomography (SD-OCT) can identify the location of choroidal rupture and subretinal hemorrhage in closed traumas (Mahesh *et al.*, 2019). In cases of ocular chemical burns, the diagnosis is predominantly clinical (Logothetis; Leikin; Patrianakos, 2014).

Currently, advanced techniques have significantly improved the diagnosis of ocular traumas. Optical Coherence Tomography (SD-OCT) and Fundus Autofluorescence (FAF) are useful for assessing the extent and severity of post-traumatic retinal damage, providing crucial information about the patient's visual prognosis. These non-invasive exams allow the evaluation of changes in the posterior segment of the eye, as well as the metabolic activity of the retinal pigment epithelium cells and anatomical changes in the outer layers of the retina (Mahesh *et al.,* 2019). Computed tomography (CT) and ocular ultrasonography are essential in evaluating open globe injuries and detecting intraocular foreign bodies, with CT correctly identifying up to 94.9% of cases and being preferred for orbital fractures, bone injuries, and acute trauma evaluation due to its speed and high resolution (Balakrishnan *et al*., 2020). B-scan ultrasonography, in turn, is safe for use in patients with metallic foreign bodies and effective in evaluating posterior segment injuries, retinal and choroidal detachments, and sequelae of acute penetrating traumas (Gomes; Castro e Silva; Ribeiro, 2019).

Ultrasonic Biomicroscopy (UBM) is highly effective in detecting anterior segment injuries, such as hemorrhages and lens dislocations, offering high-resolution images and improving diagnostic accuracy (Mahesh *et al.,* 2019). Advanced magnetic resonance imaging (MRI), despite being contraindicated in cases of magnetic foreign bodies, is useful for detailed visualization of extraocular muscles, optic nerve, and orbital structures without exposure to ionizing radiation. MRI provides excellent differentiation of soft tissue types, allowing early detection of injuries that previously could only be identified at advanced stages or through invasive techniques (Mahesh *et al*., 2019). In ocular chemical burns, the diagnosis is predominantly clinical, emphasizing the importance of the patient's history and detailed physical examination (Logothetis; Leikin and Patrianakos, 2014).

TREATMENT

The initial approach for any type of ocular trauma begins with the assessment and stabilization of the patient, followed by a detailed examination of the injured eye (Gomes; Castro e Silva and Ribeiro, 2019). In cases of closed trauma, such as contusions or corneal abrasions, therapy includes the use of antibiotic eye drops to prevent infections and anti-inflammatory eye drops to reduce inflammation (Miller, 2017). Oral analgesics may also be prescribed to relieve pain (Gomes; Castro e Silva and Ribeiro, 2019). In cases of corneal abrasion, it is important to avoid the use of contact lenses until the injury is completely healed, which usually occurs within 24 to 48 hours (Logothetis; Leikin; Patrianakos, 2014; Miller, 2017).

For penetrating or open traumas, management is more complex and often requires surgical intervention (Gomes; Castro e Silva and Ribeiro, 2019). Penetrating globe wounds require immediate surgical repair to prevent the loss of intraocular contents and infection (Miller, 2017). The procedure includes suturing the wound with non-absorbable material, such as 8-0 sutures for the sclera and 10-0 for the cornea (Logothetis; Leikin and Patrianakos, 2014). In cases of intraocular foreign bodies, surgical removal is mandatory to avoid complications such as endophthalmitis and ocular toxicity (Logothetis; Leikin and Patrianakos, 2014; Miller, 2017).

Chemical traumas, including burns caused by acids or alkalis, require immediate and abundant irrigation with saline solution or clean water to neutralize the chemical agent (Logothetis; Leikin and Patrianakos, 2014). After irrigation, the use of antibiotic and steroid eye drops is common to prevent infections and reduce inflammation (Gomes; Castro e Silva and Ribeiro, 2019). Irrigation should continue until the pH of the ocular surface is normalized (Logothetis; Leikin and Patrianakos, 2014). In severe cases, debridement of necrotic tissue and the application of therapeutic contact lenses may be necessary to promote healing (Logothetis; Leikin and Patrianakos, 2014; Gomes; Castro e Silva and Ribeiro, 2019).

In cases of hyphema, which is the accumulation of blood in the anterior chamber of the eye, treatment includes rest, elevation of the head to 30-45 degrees to facilitate blood sedimentation, and administration of cycloplegics and topical corticosteroids (Miller, 2017). Intraocular pressure should be closely monitored, and in cases of persistent elevated pressure, the use of beta-blockers or surgery to remove the accumulated blood may be necessary (Gomes; Castro e Silva and Ribeiro, 2019; Miller, 2017).

Traumatic iritis, which is the inflammation of the iris usually caused by blunt trauma, is treated with cycloplegic eye drops to relieve pain and prevent adhesions between the iris and the lens, along with topical corticosteroids to reduce inflammation (Miller, 2017). Continuous follow-up by an ophthalmologist is crucial to monitor possible complications such as the development of glaucoma or retinal detachment (Logothetis; Leikin and Patrianakos, 2014; Miller, 2017).

Chemical burns are one of the most common causes of ocular trauma and require immediate intervention. Instant irrigation is used to restore the pH to normal levels. Many authors do not recommend the use of contact lens-based devices to provide irrigation to the ocular surface, as they can cause more damage if used by untrained individuals and may not adequately irrigate the conjunctival fornices, impairing the patient's prognosis (Miller, 2017; Logothetis; Leikin and Patrianakos, 2014).

Corneal abrasions require appropriate investigation and thorough treatment. The patient's pain should be relieved with oral or topical anti-inflammatories. A recent study evidenced the use of diluted topical proparacaine for symptom relief, but its use is not recommended due to the delay in healing the injuries (Logothetis; Leikina and Patrianakos, 2014).

Pediatric ocular trauma is one of the main causes of monocular blindness worldwide, stemming from various etiologies, including physical abuse. Recent studies show that after the first ocular trauma, there is a threefold increase in the chance of a new trauma. In this sense, the use of classification systems, such as the Birmingham Eye Injury Terminology System (BETTS) and the Ocular Trauma Score (OTS), aids in decision-making and allows accurate prognosis, avoiding underestimation of injuries (Guevara, 2024).

Management of orbital trauma has also undergone modifications. It is essential to request orbital and maxillofacial imaging in computed tomography (CT) for detailed evaluation of the orbits and early detection of injuries (Balakrishnan *et al.*, 2020). In minimally or non-displaced orbital rim fractures, surgery may be avoided. For midface fractures, less invasive approaches offer better appearance and reduce complications. Orbital floor injuries are preferably treated through transconjunctival incision, minimizing the risk of entropion or ectropion and avoiding skin incisions. The placement of implants in these fractures can be assisted by the use of intraoperative CT (Lozada; Cleveland and Smith, 2019).

Soft tissue trauma requires prompt repairs for better postoperative outcomes. Contaminated wounds should be irrigated with sterile saline solution, and there is no contraindication for immediate repair. Healing by secondary intention is not recommended in areas where scars may cause deformities or movement limitations, such as the upper eyelid crease or lower eyelid. The presence of foreign bodies indicates imaging exams, with CT being the examination of choice for penetrating injuries and traumas with unknown mechanisms, with mandatory removal of the object in a surgical center (Ko *et al.*, 2021).

The development of glaucoma after ocular trauma is a consequence evidenced in several studies. In chemical injury, intraocular pressure (IOP) can be controlled in the acute phase with topical glaucoma medications. There is no consensus regarding the contraindication of using prostaglandin analogs and pilocarpine in trauma. If IOP increases after medication option, surgical approach is necessary. Prolonged use of steroids after traumatic iritis can lead to IOP elevation, controlled with antiglaucoma agents, except prostaglandin analogs in cases of uveitis. In hyphema, the same drug therapy is indicated, with surgical intervention performed in young and healthy individuals with normal optic nerve when IOP is >50 mmHg for more than 5 days, >45 mmHg for more than 1 week, or >35 mmHg for more than 2 weeks. In the treatment of phacomorphic glaucoma, laser peripheral iridotomy (LPI) before surgical intervention benefits all individuals, preventing an acute attack and quickly controlling IOP (Razeghinejad *et al.*, 2020).

According to the World Health Organization (WHO), 90% of people with visual impairment live in low-income countries. About 28% of people with moderate to severe visual impairment are of working age, significantly impacting their professional and economic lives. Approximately 80% of visual impairment cases could be avoided or treated, but access to prevention, education, treatment, and rehabilitation services is very limited (Guevara, 2024).

Ophthalmic emergencies can lead to vision loss, making it crucial to recognize and communicate ophthalmic findings to prevent irreversible visual damage. An initial comprehensive examination, including visual acuity, intraocular pressure, and pupil evaluation, is essential. Additionally, referral for continuous ophthalmic follow-up is necessary to rule out complications and ensure proper care after initial treatment (Logothetis; Leikin and Patrianakos, 2014).

Ocular trauma can cause elevated intraocular pressure (IOP), making it essential to understand and identify the causes of this elevation in each case to choose appropriate therapeutic approaches. Initial IOP measurement can provide critical information about the need for surgical intervention (Razeghinejad *et al.*, 2020).

According to Miller (2017), ocular traumas in children can lead to vision loss. Closed globe injuries are treatable on an outpatient basis and generally have better visual outcomes. In contrast, open globe injuries have a poorer visual prognosis, often requiring surgical intervention due to delays in initial treatment.

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