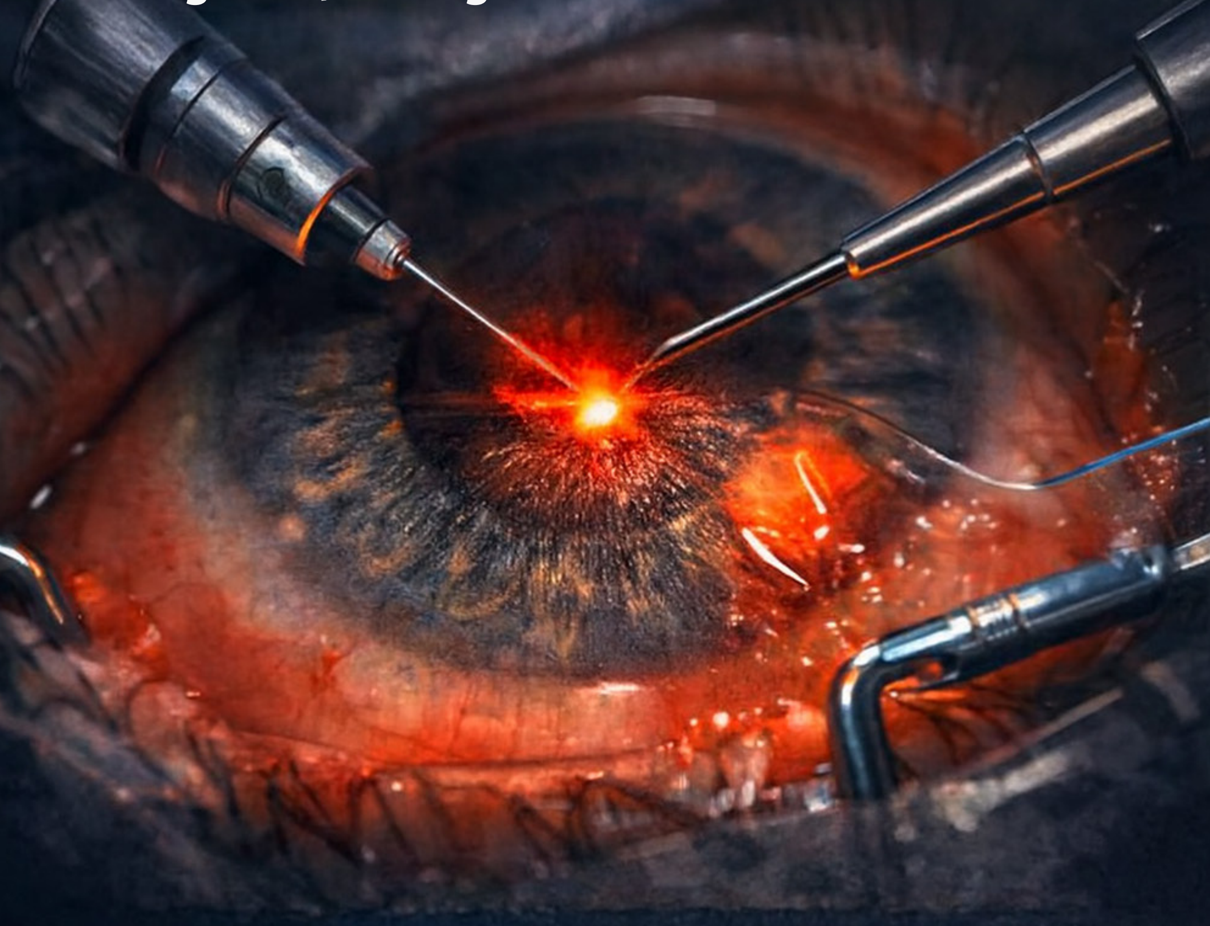
Modern Approaches to OCULAR TRAUMA

Diagnosis, Management and Rehabilitation



Editor
Muhammed Batur, Professor, MD

MHA
MEDIHEALTH ACADEMY

CONTENTS

SECTION 6. INNOVATIONS AND FUTURE DIRECTIONS

PREFACE

Ocular trauma represents one of the most challenging fields in ophthalmology, requiring a truly multidisciplinary approach. From diagnosis to treatment, and from surgical management to rehabilitation, the care of ocular trauma patients demands not only technical expertise and experience but also rapid decision-making, teamwork, and long-term follow-up. Throughout my years of clinical practice and scientific research, it has become increasingly clear that there is a significant need for a comprehensive, up-to-date, and practical reference in this field.

Motivated by this need, Modern Approaches to Ocular Trauma: Diagnosis, Management and Rehabilitation was conceived to provide a contemporary, evidence-based, and multidimensional perspective on ocular trauma. The book is structured into six main sections and thirty chapters. Each section has been coordinated by an expert editor, and each chapter has been authored by specialists with substantial experience in their respective fields. In this respect, the book represents a true product of collective knowledge and collaborative effort. I would like to express my sincere gratitude to all editors and authors for their dedication and contributions despite their demanding clinical and academic responsibilities.

The creation of this book reflects not only an academic endeavor but also a journey requiring considerable time and commitment. Throughout this process, the greatest support came from my family. My wife and children shared the unseen burden of the time devoted to this work with patience and understanding, becoming the most important—though often invisible—contributors to this project. Without their presence and unwavering support, the completion of this book would not have been possible. For this reason, I dedicate this book, first and foremost, to my wife and children.

It is my hope that this volume will serve as a valuable guide for ophthalmologists, residents, and all healthcare professionals involved in the management of ocular trauma, and that it will also contribute to future scientific research in this field.

Sincerely,

Muhammed Batur, Prof., MD
Ankara, 2026

CHAPTER 3

Innovations in Diagnostic Imaging for Eye Trauma

Ender Şener

ABSTRACT

Ocular trauma remains a leading cause of unilateral visual impairment and blindness worldwide. In a substantial proportion of eye injuries presenting to emergency departments, direct ophthalmoscopic visualization of intraocular structures is frequently limited by opaque media such as hemorrhage or cataract, eyelid edema, and insufficient patient cooperation. Under these conditions, advanced diagnostic imaging modalities become essential for accurately delineating the extent of injury, identifying intraocular foreign bodies (IOFBs), and guiding appropriate surgical management. This book chapter provides a focused and up-to-date overview of contemporary innovations in diagnostic imaging for ocular trauma and their clinical applications. The indications and limitations of cross-sectional imaging techniques are reviewed, with particular emphasis on Computed Tomography (CT) as the gold standard for the detection of orbital fractures and foreign bodies, and Magnetic Resonance Imaging (MRI) for selected cases requiring superior soft-tissue characterization. In addition, the evolving diagnostic roles of ultrasonography in bedside assessment and Optical Coherence Tomography (OCT) in high-resolution microstructural evaluation of anterior and posterior segment trauma are discussed. Practical usage algorithms for Ultrasound Biomicroscopy (UBM) and angiographic imaging in specific trauma scenarios, including closed-globe injuries and traumatic optic neuropathy, are also presented. In conclusion, this chapter highlights the importance of a tailored, multimodal imaging approach in the evaluation of traumatic eye injuries and aims to provide ophthalmologists and emergency clinicians with a concise, clinically relevant framework for imaging selection, interpretation, and prognostic assessment.

INTRODUCTION

Ocular trauma remains a leading cause of unilateral visual impairment worldwide. In the United States, eye-related emergencies account for approximately 1.5% to 3% of all emergency department visits.[1]

Imaging modalities in ocular trauma provide critical information not only for ophthalmologists but also for emergency clinicians. They play a key role in identifying the presence and type of injury following trauma, assessing the need for urgent intervention, planning appropriate emergency management, and predicting visual prognosis. This field has been evolving rapidly in recent years. Although ocular imaging continues to advance quickly, it does not replace the clinical judgment of an ophthalmologist. When diagnostic uncertainty persists despite imaging, surgical exploration remains essential and should be considered.

In cases of ocular trauma, direct visualization of intraocular structures through ophthalmoscopy may be hindered or impossible, particularly when hemorrhage or other trauma-induced changes render the transparent ocular media opaque. Additionally, factors such as eyelid edema, ecchymosis, pain, altered mental status, uncooperative behavior, or pediatric age can complicate clinical examination. Under these circumstances, imaging becomes an indispensable tool for detecting ocular pathology. Common imaging modalities used in ocular trauma include plain radiography (X-ray), computed tomography (CT), ultrasonography (US), and magnetic resonance imaging (MRI).

PLAIN RADIOGRAPHY (X-RAY)

Historically, plain radiographs were the primary imaging modality for diagnosing orbital and orbitofacial fractures and for identifying intraorbital metallic foreign bodies. However, their routine use has declined significantly due to a high rate of false-negative and occasional false-positive results. Additionally, they are often inadequate for detecting intraocular foreign bodies of organic origin, especially in cases of organic trauma. Consequently, X-rays are no longer used as a standalone diagnostic method. Nonetheless, they may still serve as an initial screening tool to detect radiopaque foreign bodies within or near the orbit.[3] Despite this application, X-rays remain limited in their ability to assess soft tissue damage and bone fragment displacement.

COMPUTED TOMOGRAPHY (CT)

CT is currently the preferred method for assessing orbital trauma, as it provides rapid, high-resolution imaging of both bone and soft-tissues. It is especially effective for detecting fractures, bone fragments, and radiopaque foreign bodies. High-resolution multidetector CT is considered the gold standard for evaluating orbital trauma and planning surgical interventions. Fractures, displaced bone fragments, small comminuted fragments, and radiopaque foreign materials are best identified using CT imaging.[4] This imaging modality informs treatment planning and assists clinicians in deciding between emergency intervention, delayed surgery, or conservative (non-surgical) management.

CT has higher sensitivity than X-ray in detecting orbital wall fractures. Moreover, three-dimensional reconstructions derived from CT images are especially valuable in preoperative planning, providing guidance in complex surgical cases. Over the past five decades, CT has become indispensable in clinical diagnostics due to its ability to generate submillimeter cross-sectional images of nearly any region of the body. Thin-slice CT scans enhance image quality and diagnostic accuracy by enabling clearer visualization of small anatomical structures and lesions. However, these advantages often come with increased radiation exposure.[5] Due to its superior resolution, speed, and accessibility, CT is particularly well-suited for evaluating acute traumatic ocular conditions.[4]

Ocular trauma can be classified as either open-globe injuries, including contusions, lamellar lacerations, extraocular foreign bodies, and intramural foreign bodies.[6] CT imaging plays a crucial role in identifying these pathologies, particularly fractures involving the orbital walls. The most commonly observed orbital fracture affects the orbital floor,[7] followed by fractures of the medial wall. Additional fracture patterns, such as orbital roof fractures, zygomaticomaxillary complex fractures, Le Fort fractures, naso-orbito-ethmoid fractures, and orbital apex fractures, can also be detected using CT imaging[8] (**Figure 1**).

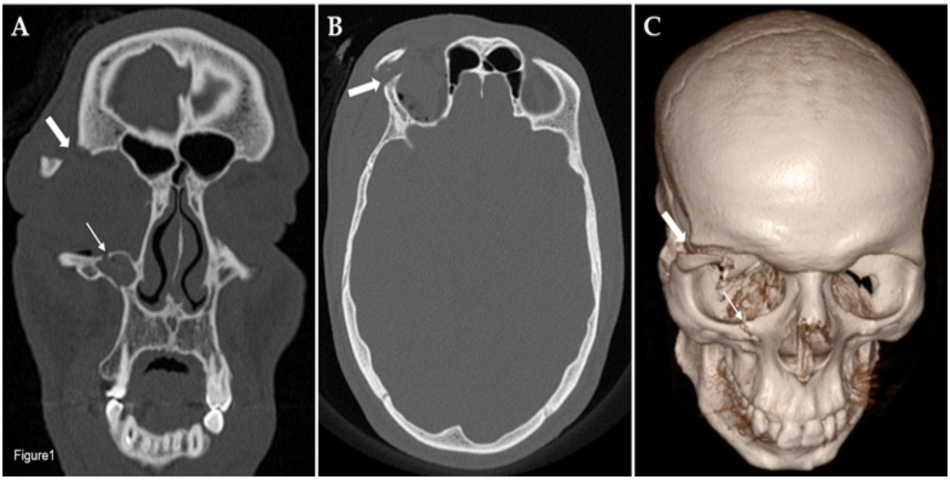


Figure 1. Fracture: A) Coronal reformatted computed tomography; B) Axial computed tomography; C) Three-dimensional computed tomography showing a fracture line (thin arrow) on the right orbital floor and anterior wall of the maxillary sinus. Segmented, displaced, separate fracture lines (thick arrow) are visible on the right orbital roof and lateral wall.

Open globe injuries represent severe ophthalmic emergencies that pose a significant threat to vision and may result in devastating, lifelong consequences. Early detection of such injuries is critical for timely and effective intervention. When open globe trauma is suspected or confirmed, clinical manipulation should be avoided. Even minimal palpebral pressure from ocular ultrasound may pose a risk. In such cases, CT is the preferred diagnostic method. CT imaging provides vital support to both emergency clinicians and ophthalmologists in these scenarios.[9] In a systematic review and meta-analysis by Aljuhani et al.,[10] the most prominent CT features suggestive of open globe injuries included globe contour irregularity or wall discontinuity, shallow anterior chamber, lens dislocation, intraocular hemorrhage, intraocular foreign bodies, intraocular emphysema, globe volume loss, and retinal detachment. Ibanez et al.[11] confirmed similar findings in their study. Among these, globe deformity or scleral irregularity was the most frequent finding, followed by intraocular hemorrhage[10] (**Figure 2**). In a study by Chieh Chou and colleagues,[12] the diagnostic accuracy of CT in detecting globe rupture was found to be higher in patients with orbital wall fractures, particularly those involving the lateral orbital wall. Arabi et al.[13] reported that the sensitivity and specificity of coronal CT scans in detecting open globe injuries were 65% and 89%, respectively, while axial CT scans showed slightly better values, with 74% sensitivity and 90% specificity. Combining axial and coronal scans increased diagnostic sensitivity to 79% and specificity to 93%. The authors suggested that axial CT imaging alone may be adequate for promptly diagnosing open globe injuries that require urgent intervention. In a separate study, Aljuhani et al.[10]

SECTION 2
ANTERIOR SEGMENT TRAUMA

CHAPTER 1

Advances in Managing Corneal and Scleral Lacerations

Rümeysa Bilmez Tan

ABSTRACT

Ocular trauma is one of the leading causes of monocular blindness worldwide. Open globe injuries, particularly those involving corneal and scleral lacerations, represent full-thickness disruptions of tissue integrity that result in exposure of intraocular contents to the external environment. These injuries are classified into three zones (Zone 1, 2, and 3) according to their anatomical location and predominantly affect young adult males and children. The management process begins with the exclusion of life-threatening conditions, followed by a detailed medical history and a careful ophthalmologic examination. During the diagnostic phase, computed tomography (CT) plays a critical role, especially in the detection of metallic intraocular foreign bodies. Surgical repair is ideally performed within the first 24 hours after injury. While bandage contact lenses or tissue adhesives may be used for small corneal lacerations, larger, irregular, or tissue-loss–associated injuries require primary repair with 10-0 nylon sutures. Surgical techniques include the Roswey-Hays method, which prevents central corneal steepening, as well as the Eisner and Akkın techniques developed for stellate lacerations. In scleral injuries, complications such as uveal tissue prolapse and vitreous loss must be managed carefully, and the "divide-and-conquer" rule should be applied during surgical repair. Broad-spectrum antibiotic prophylaxis and tetanus immunization should not be neglected to prevent post-traumatic endophthalmitis. In conclusion, rapid diagnosis, appropriate surgical timing, and meticulous postoperative follow-up are essential to improve visual prognosis in open globe injuries.

Definition and Classification of Corneal and Scleral Lacerations

Ocular globe injuries are classified as either open or closed globe injuries. Open globe injuries may result from blunt or sharp trauma.[1] These injuries are characterized by full-thickness disruption of the cornea and/or sclera, which exposes the intraocular contents to the external environment.[2] In cases of sharp trauma, if the entry and exit wounds are at different locations, the injury is classified as a perforating globe injury.[1] If the entry and exit sites coincide, the injury is referred to as a penetrating globe injury.

To describe the anatomical locations of these injuries, the globe is divided into three zones. Zone 1 includes the corneal area within the limbus. Zone 2 extends from the limbus to 5 mm posteriorly. Zone 3 encompasses regions located more than 5 mm posterior to the limbus (**Figure 1**).

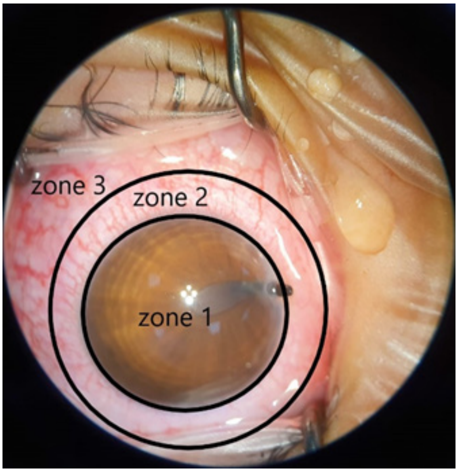


Figure 1. Illustration of trauma zones

Epidemiology

Ocular trauma is one of the leading causes of monocular blindness worldwide.[2] The incidence of open globe injuries ranges from 2 to 6 cases per 100.000 individuals.[3] Although open globe injuries can occur at any age, epidemiological studies often report a higher frequency in individuals aged between 10 and 30 years.[3] The majority of cases involve males.[1] In a study conducted by Batur et al.,[4] it was reported that men are approximately four times more likely to experience open globe injuries compared to women. The risk of open globe injury is higher in populations with low socioeconomic status.[5]

According to a study conducted in Turkiye that classified the localization of open globe injuries, corneal lacerations were identified as the most common type. Corneoscleral injuries were the second most frequent, while scleral injuries were reported to be the least common.[6]

Etiology

In the young adult population, a significant proportion of injuries are work-related. In the pediatric age group, domestic accidents represent the most common cause of open globe injuries.[7] Occupational accidents, traffic accidents, and sports-related trauma are also among the leading causes of open globe injuries.[1]

MANAGEMENT STRATEGY FOR PENETRATING OCULAR INJURIES

When a patient presents with ocular trauma, the clinician must first assess for any life-threatening injuries involving other organ systems. In cases of multiple trauma, a treatment plan should be developed in collaboration with other medical specialties. Life-saving interventions must take precedence over ocular assessment and treatment. Once the patient is stabilized, the extent of ocular trauma should be evaluated, and a

CHAPTER 5

Iris Trauma and Functional Implications

Murat Erdağ

ABSTRACT

This chapter provides a comprehensive analysis of the anatomical structure, pathophysiology, and clinical management of iris trauma. The iris serves as a dynamic diaphragm regulating light entry and aqueous humor dynamics through its complex four-layered structure and autonomic innervation. Injuries resulting from blunt, penetrating, or surgical trauma frequently lead to significant complications, including hyphema, iridodialysis, and traumatic aniridia. These structural defects impair visual quality by causing photophobia and reduced contrast sensitivity, while also risking intraocular pressure instability such as secondary glaucoma or hypotony. Management strategies involve medical interventions with anti-inflammatory and mydriatic agents to control intraocular inflammation. Surgical rehabilitation is categorized into advanced suturing techniques—including the McCannel suture, Siepser sliding knot, and single-pass four-throw (SFT) pupilloplasty—and pupillary cerclage for permanent mydriasis. For extensive tissue loss, the chapter details iridodialysis repair via the "sewing machine" technique and the implantation of various prosthetic iris devices, such as iris-lens diaphragms or foldable silicone implants. Successful outcomes necessitate precise preoperative assessment and vigilant long-term monitoring of ocular integrity.

ANATOMICAL POSITION AND STRUCTURE OF THE IRIS

The iris is a pigmented, circular structure located in the anterior segment of the eye, positioned between the cornea and the crystalline lens. It functions as a dynamic diaphragm that regulates the amount of light entering the eye by adjusting the size of the pupil. Structurally continuous with the ciliary body, the iris forms part of the uveal tract. Its base is anchored to the anterior border of the ciliary body, and it plays a crucial role in aqueous humor dynamics. By modulating the flow of aqueous humor through the iridocorneal angle and trabecular meshwork, the iris helps regulate intraocular pressure.

STRUCTURAL LAYERS OF THE IRIS

The iris consists of four distinct layers, each with specific structural and functional properties. The anterior border layer is the outermost layer, composed of fibroblasts and melanocytes. This layer is not uniform and exhibits unique patterns, similar to fingerprints, which account for the individual variability of irises. The crypts of Fuchs, visible as gaps in the anterior border layer, are developmental remnants formed during embryogenesis. Beneath the anterior border layer lies the stroma, a loose connective tissue matrix containing collagen fibers, fibroblasts, melanocytes, nerves, and blood vessels. The stroma houses the sphincter pupillae muscle, which is responsible for pupillary constriction. The density and distribution of melanocytes within the stroma influence the color of the iris, with darker eyes having a higher concentration of melanin.

The muscular layer of the iris comprises two opposing muscles that regulate pupil size. The sphincter pupillae muscle is a circular band of smooth muscle fibers surrounding the pupillary margin and is responsible for miosis (pupil constriction), which is mediated by parasympathetic innervation. In contrast, the dilator pupillae muscle consists of radially arranged fibers extending toward the iris periphery and mediates mydriasis (pupil dilation) under sympathetic control. The posterior pigment epithelium forms the innermost layer of the iris. It consists of two layers of pigmented epithelial cells derived from the neuroectoderm, creating a dense barrier that reduces light scatter. The anterior layer of this epithelium extends forward to contribute to the formation of the dilator pupillae muscle, highlighting the developmental link between the pigment epithelium and the iris musculature.

VASCULAR SUPPLY AND VENOUS DRAINAGE

The iris is supplied by two interconnected vascular networks: the major and minor arterial circles. The major arterial circle (circulus arteriosus major) is located near the iris root and is formed by the long posterior ciliary arteries and the anterior ciliary arteries. From this network, radial branches extend toward the pupil, forming the minor arterial circle (circulus arteriosus minor) at the collarette, which supplies the pupillary margin and the sphincter pupillae muscle. Venous drainage of the iris occurs through the vortex veins and the ciliary venous plexus, ensuring efficient blood circulation.

INNERVATION OF THE IRIS

The iris is innervated by both autonomic and sensory nerve fibers. The parasympathetic nervous system controls pupillary constriction through fibers originating from the oculomotor nerve (cranial nerve III). These fibers synapse in the ciliary ganglion before reaching the sphincter pupillae muscle via the short ciliary nerves. In contrast, sympathetic innervation arises from the superior cervical ganglion and travels through the long ciliary nerves to innervate the dilator pupillae muscle, facilitating pupillary dilation. Sensory innervation is provided by the ophthalmic division of the trigeminal nerve, which transmits afferent signals from the iris to the central nervous system.[1]

PATHOPHYSIOLOGY OF IRIS TRAUMA

Eye injuries are a significant global health issue and a leading cause of unilateral blindness. In the United States, approximately 3.15 eye injuries per 1,000 people are treated in emergency departments annually. Furthermore, about one-third of patients with severe eye injuries do not recover visual acuity better than 20/200.[2]

Iris Repair Techniques

Iris repair techniques aim to restore the structural and functional integrity of the iris while minimizing light sensitivity (photophobia) and enhancing visual quality. The choice of technique depends on the extent of iris damage, the presence of associated ocular injuries, and the overall visual prognosis.

Iris Suturing Techniques

Pupilloplasty is one of the oldest techniques developed to repair iris defects. It aims to reshape the iris by using sutures to create a round pupil and close the defect. In cases involving partial iris defects or iridodialysis (detachment of the iris root from the ciliary body), suturing techniques can help reposition and stabilize the remaining iris tissue.

McCannel suture technique: This technique is used to close iris defects and reposition the pupil. It involves passing 10-0 polypropylene sutures through the peripheral iris and securing them via a corneal incision.

This approach involves making two small incisions at the limbus, positioned opposite each other on either side of the defect.

A viscoelastic substance is injected into the anterior chamber to maintain space and protect intraocular structures.

A fine needle carrying a 10-0 polypropylene suture is inserted through one of the incisions and passed through the edges of the iris defect to secure the tissue.

To facilitate suturing, a corneal incision is made between the two paracentesis sites, allowing the iris tissue to be gently pulled out.

The sutures are tied externally before repositioning the iris back into the anterior chamber, effectively restoring its structure and function. Modified variations of this technique are also available (see **Figure 1**).[6]

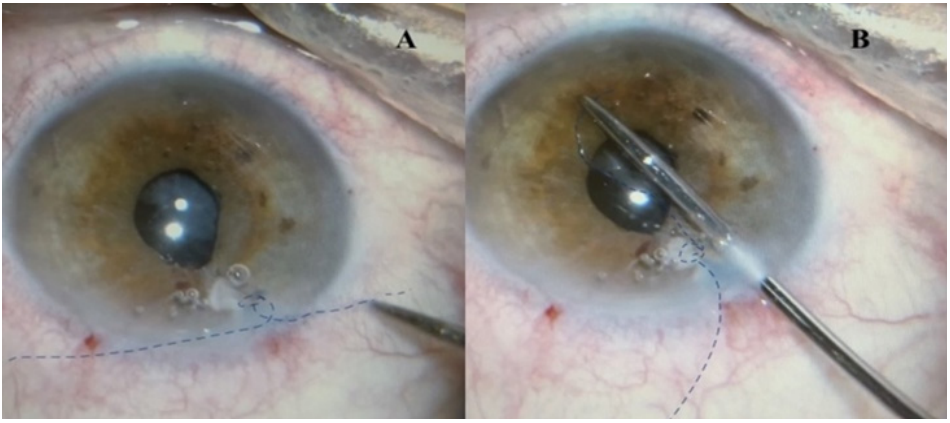


Figure 1. Intraoperative view demonstrating both the McCannel technique and the modified McAhmed technique for iris suturing

Siepser sliding knot technique: This adjustable knot technique is especially useful for closing small iris tears and repairing iridodialysis. The sliding knot method is a refinement of the McCannel suturing technique, employing a closed system approach that enables knot tying outside the eye while maintaining a sealed anterior chamber.

Viscoelastic material is injected into the anterior chamber to maintain space and protect intraocular structures.

The procedure begins with two paracentesis incisions and the insertion of a 10-0 polypropylene suture. A microhook is then used to pull a suture loop from the opposite side of the anterior chamber through the proximal paracentesis incision.

The surgeon ties a double-throw slipknot, which is tightened by pulling both ends, ensuring secure iris fixation with minimal intraocular manipulation.

This technique can be performed multiple times for larger iris defects to ensure proper closure and stability[7] (**Figure 2**–Courtesy of Mehmet CITIRIK).

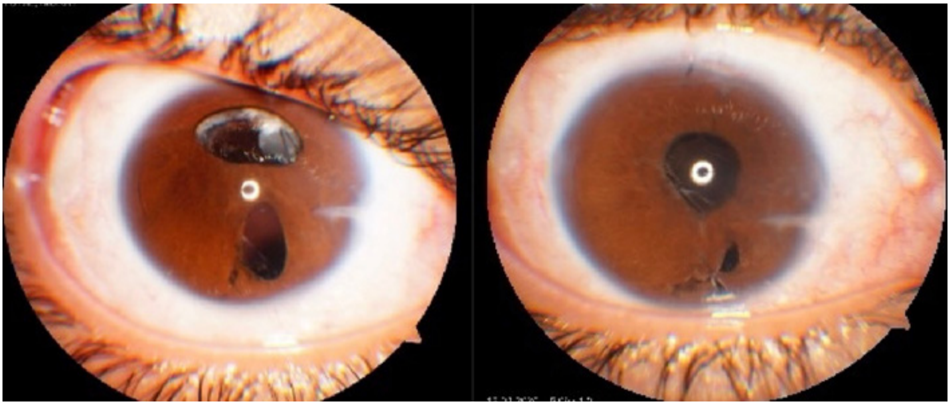


Figure 2. Iris reconstruction using the Siepser sliding knot technique (Image courtesy of Mehmet Çıtırık, MD)

The single-pass four-throw (SFT) pupilloplasty technique is a modification of the Siepser knot technique. It secures the iris tissue by forming a four-throw helical knot instead of a square knot.

The procedure begins with the creation of two small limbal incisions along the axis of the pupillary defect. A 10-0 polypropylene suture with a long needle is introduced through the first incision and passed through the proximal iris defect, while forceps apply counter-tension to stabilize the iris.

The suture is then passed through the distal iris tissue and retrieved, creating a loop in the anterior chamber.

Using a hook, the loop is externalized through the distal incision, and the distal suture end is passed through the loop four times, forming a helical structure.

CHAPTER 2

Post-traumatic Retinal Detachment: Challenges and Innovations in Repair

Gökhan Demir, Eyüp Özcan

ABSTRACT

Traumatic retinal detachment, which can occur early or late following closed or open eye injuries, can lead to permanent vision loss. A significant proportion of retinal detachments, especially in children, develop due to trauma, and potential delays in diagnosis, coupled with incomplete maturation of the visual system, can result in severe vision loss. In cases of retinal detachment following open eye injury, the ideal treatment is restoration of eye integrity within the first 24 hours, followed by vitreoretinal surgery between days 10-14; however, retinal tears and detachments following closed injuries should be treated as soon as possible. Low baseline visual acuity, the presence of open eye injury, intraocular foreign bodies, and proliferative vitreoretinopathy have been found to be associated with a poor prognosis.

TRAUMATIC RETINAL DETACHMENT

One significant consequence of ocular trauma is retinal detachment. The incidence of retinal detachment in the general population ranges from 10.1 to 12.4 per 100,000 individuals, with trauma accounting for approximately 0.8% of cases.[1-3] The incidence is considerably lower in the pediatric population, estimated at around 2.5 to 2.9 per 100,000 for individuals aged 10 to 19, and 0.6 per 100,000 for children under 9 years old.[4] However, it is known that the vast majority of retinal detachments in the pediatric population (61%) are trauma-related. Although there is no universally accepted definition of traumatic retinal detachment, detachments occurring after closed or open eye injuries are generally classified as traumatic in origin.[5] Recognizing traumatic retinal detachment is important for the following reasons:

- Other traumatic ocular pathologies that may accompany include angle recession, zonular dialysis, and silent intraocular foreign bodies; therefore, a detailed ophthalmologic examination should be performed to detect these conditions.

- Prognosis of the fellow healthy eye: Although the fellow eye of a patient with idiopathic rhegmatogenous retinal detachment is at a relatively high risk of developing retinal tears, there is no increased risk for the fellow eye in cases of traumatic retinal detachment.

- Multi-system evaluation: Traumatic retinal detachment may have legal implications, such as those related to workplace accidents, injuries, or child abuse. Additionally, damage to other systems and organs may accompany the condition. For this reason, pediatric retinal detachment cases, in particular, should be carefully evaluated from this perspective.

Figure 1. Retinal dialysis in the superionasal quadrant

remains good. In a study of 48 cases of rhegmatogenous retinal detachment caused by retinal dialysis, macular involvement was present in 85% of cases at diagnosis, and stage C proliferative vitreoretinopathy was detected in 25%.[29] Another important consideration is that retinal dialysis can occur at multiple sites. In a study of 63 cases with retinal dialysis-related detachment, multiple dialysis areas were observed in the same eye in 29% of cases.[30] Thus, it is essential to carefully examine all retinal quadrants. In the vast majority of retinal dialysis cases, the posterior hyaloid remains attached. It is likely that the posterior vitreous cushions the torn retina during the interval between ocular trauma and the development of retinal detachment. However, this may contribute to the slow progression of detachment, delayed diagnosis, and poor postoperative visual prognosis. Additionally, the firm adhesion of the posterior vitreous favors scleral buckling surgery, particularly in pediatric patient.

Giant Retinal Tear

Full-thickness retinal defects exceeding 90 degrees, accompanied by vitreous detachment, are called giant retinal tears.[31]

1.5% of all rhegmatogenous retinal detachments result from giant retinal tears, with the majority of cases (72%) occurring in males. Of these giant retinal tears, 54% are idiopathic, 25% are associated with high myopia, 14% are linked to hereditary conditions such as Marfan syndrome, Stickler-Wagner syndrome, and Ehlers-Danlos syndrome, and 12% are secondary to ocular trauma. Additionally, 16% of all giant retinal tears have a documented history of trauma.[31-34]

Unlike retinal dialysis, the vitreous is typically attached to the anterior flap of the tear, while the posterior retina remains free and mobile, sometimes folding onto itself (**Figure 2**).[35] Pars plana vitrectomy is the preferred surgical approach because most cases involve advanced proliferative vitreoretinopathy and active vitreous traction at the tear site.[36] However, scleral buckling surgery may also be performed if the tear is localized inferiorly and does not exceed one quadrant.

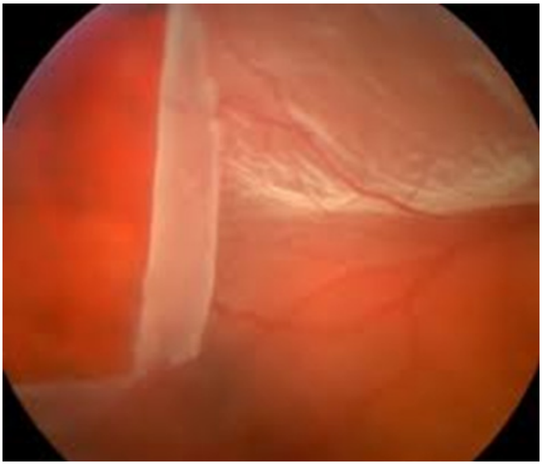


Figure 2. Giant retinal tear folded in on itself

Retinal Tear

Retinal tears typically occur shortly after blunt ocular trauma and can lead to retinal detachment if not detected early and treated with retinopexy. Vitreous hemorrhage may accompany retinal tears, complicating early detection. Additionally, untreated traumatic retinal tears increase the risk of developing proliferative vitreoretinopathy (**Figure 3**). Therefore, patients with vitreous hemorrhage following ocular trauma should be closely monitored for possible underlying retinal tears, and early vitrectomy should be considered if the hemorrhage does not clear. Although traumatic retinal tears are usually localized in the temporal quadrant, multiple tears in different quadrants may also occur.[6]

Figure 3. Retinal tear with proliferative vitreoretinopathy

Retinal Incarceration

In cases of rupture caused by a closed-eye injury or perforating injury resulting from an open-eye injury, the vitreous, retina, and choroid may become incarcerated within the scleral wound (**Figure 4**).

In cases of rupture caused by a closed eye injury or perforating injury resulting from an open eye injury, the vitreous, retina, and choroid may become incarcerated within the