Original Article

A Study of Orbital Fractures

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ABSTRACT

Aim: To study the etiology, the types of orbital fractures, their clinical presentation, management strategies, outcomes, and prognosis.

Materials and Methods: This prospective observational study was conducted on 17 patients with orbital fractures who presented to the Department of Ophthalmology of a government medical college in Visakhapatnam, Andhra Pradesh. The evaluation consisted of a detailed history, visual acuity, color vision, ocular motility, forced duction test (FDT), diplopia charting, Hertel's exophthalmometry, and a detailed anterior and posterior segment examination. All patients underwent a plain computerized tomography (CT) scan of the orbit. Patients with traumatic optic neuropathy received intravenous (IV) Methylprednisolone as soon as diagnosis while those who needed surgery were referred to a center having multidisciplinary specialists. Others were treated conservatively.

Results: Most of the cases were males, with the major cause being road traffic accidents (RTA) followed by industrial accidents. Single wall fracture was the most common type and the rest were complex combined fractures. Nearly a third of the patients presented with diplopia, relative afferent pupillary defect (RAPD), and enophthalmos. While nearly half of the presenting cases improved with IV methylprednisolone, the rest required surgical management. Significant improvement in vision, color vision, and ocular motility was noticed in either management strategy. Poor prognosis was noticed in those who presented with a perception of light (PL) at the first visit.

Conclusions: Good results in orbital fractures are often provided by timely intervention and the visual prognosis depends on initial visual acuity at presentation.

Keywords: Orbit, fractures, road traffic accidents, methylprednisolone.

INTRODUCTION

The orbit represents a microcosm of the body in terms of tissues present- muscle, adipose tissue, blood vessels, nerves, skin, bone, glands, ganglions[1], and lymphatics in some parts[2]. Since the orbit is in close relationship with the cranial cavity, the nose, and paranasal sinuses, it is vulnerable to getting affected during trauma. A profound impact in the diagnosis and management has been made by recent advances in imaging, and management both by surgical and non-surgical methods, thus early intervention is important to prevent the threatening complications that may arise.

METHODOLOGY

This prospective observational study was conducted on 17 patients with orbital fractures who presented to the Department of Ophthalmology of a government medical college in Visakhapatnam, Andhra Pradesh from January 2023 to September 2023.

Inclusion criteria: All new cases of orbital trauma that consented for evaluation and management and followed up for a minimum period of 3 months.

Exclusion criteria: Patients who have already undergone treatment elsewhere before attending our department and those who did not undergo treatment or lost to follow-up.

Patient Evaluation - After informed consent, data was collected. The evaluation consisted of detailed clinical history, visual acuity by Snellen's chart, ocular motility, forced duction test (FDT), Color Vision by Ishihara's chart, pupil examination to rule out relative afferent pupillary defect (RAPD), Diplopia charting, Hertel's exophthalmometer for enophthalmos, and a detailed anterior and posterior segment evaluation by slit lamp and 90 D lens. Specific clinical signs of orbital fracture diagnosis were looked for, which included periorbital ecchymosis, step-offs, crepitus, surgical emphysema, tenderness, and any hypo or hyperesthesia.

Investigation: All patients underwent a plain computerized tomography (CT) scan of the orbit.

Management: Patients with traumatic optic neuropathy received intravenous (IV) Methylprednisolone as soon as a diagnosis while those who needed surgery were referred to a center having multidisciplinary specialists. Others were treated conservatively.

Statistical analysis: The observations were classified according to two attributes and frequencies in the different categories in two-way tables. Chi-square (X2) criteria based on observed and expected cell frequencies were used to analyze the contingency tables.

RESULTS

chart 1: sex distribution

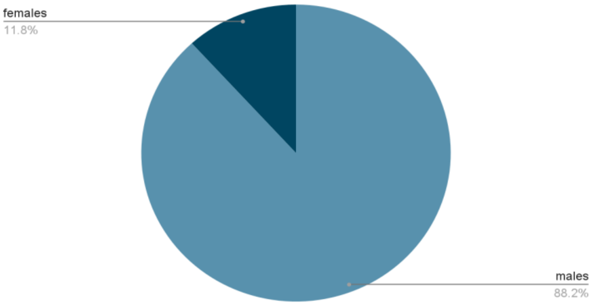


chart 2: etiology of fractures

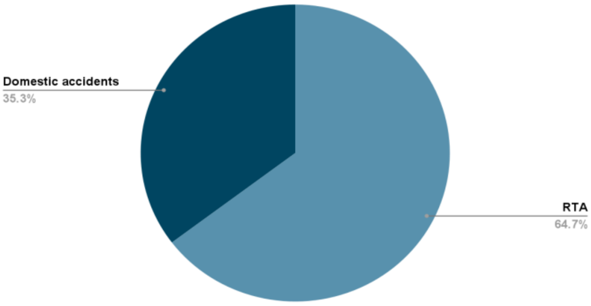


chart 3 : type of fractures

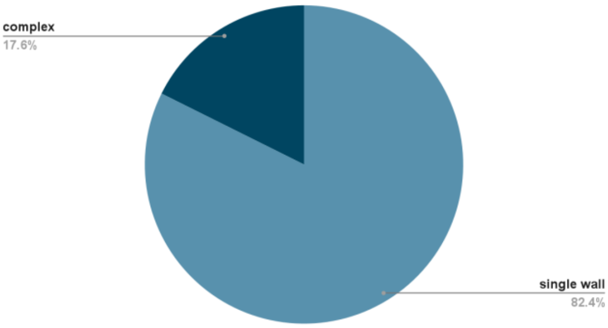


chart 4: symptoms

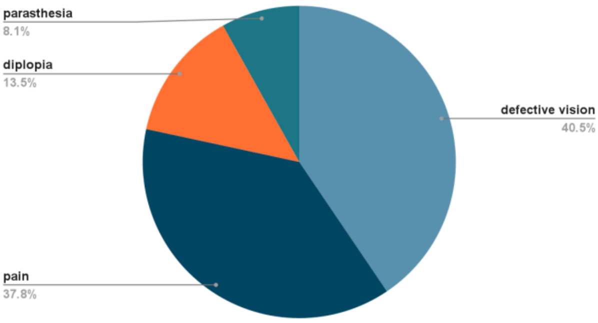


chart 5: clinical signs

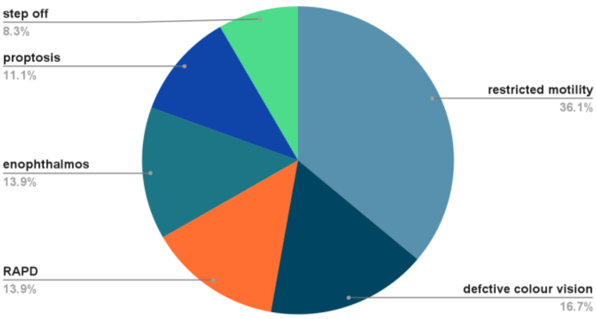
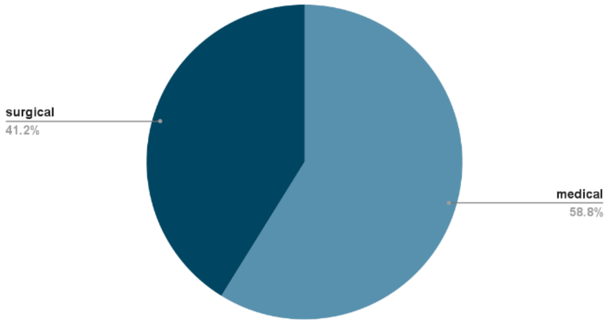


chart 6: management strategy



Most of the cases were males (88.2%). The majority were due to road traffic accidents (RTA) (65%) followed by domestic accidents (35. %). Single wall fracture was the most common type (82.3%) and the rest were complex combined fractures. Medial wall and floor were involved in 5 cases each (29.4%), lateral wall in 4 cases (23.5%), and roof in 1 (5.8%). 88% and 82 % presented with defective vision and pain respectively. While defective color vision was noted in 16.7%, diplopia, RAPD and enophthalmos were observed in 13.9 % each. The vision ranged from 6/6 to no PL. Out of 58.8 % of medically managed cases, 6 patients (35.2%) with traumatic optic neuropathy received I V Methylprednisolone. A total of 7 patients (41.1%) having enophthalmos, diplopia, and fracture impingement with positive forced duction test (FDT) were sent to a multidisciplinary center for surgery i.e. orbital fracture exploration, with removal of impinging fracture and orbital plating. Significant improvement was noticed in all the patients who were treated by surgery and those who received IV Methylprednisolone except one who presented with no PL.

DISCUSSION

Anatomy of the orbit [3, 4]

Each bony orbit is pear-shaped, tapering posteriorly to the apex and the optic canal. The medial wall is thinnest; the lateral wall is strongest while the floor is shortest and doesn't reach the apex. The orbit is composed of seven bones namely, frontal, sphenoid, zygomatic, maxillary, lacrimal, ethmoid, and palatine bones.

Roof of the orbit – It is composed of the frontal bone and the lesser wing of the sphenoid. Important landmarks: the lacrimal gland fossa, which contains the orbital lobe of the lacrimal gland; the fossa for the trochlea of the superior oblique tendon, located 5 mm behind the superior nasal orbital rim; and the supraorbital notch, or foramen, which transmits the supraorbital vessels and branch of the frontal nerve

Medial wall of the orbit –It is composed of the ethmoid, lacrimal, maxillary, and sphenoid bone. Important landmarks: the frontoethmoidal suture, marking the approximate level of the cribriform plate, the roof of the ethmoids, the floor of the anterior cranial fossa, and the entry of the anterior and posterior ethmoidal arteries into the orbit located adjacent to the ethmoid and sphenoid sinuses and nasal cavity. The thinnest walls of the orbit are the lamina papyracea, which covers the ethmoid sinuses along the medial wall, and the maxillary bone, particularly in its posteromedial portion. These are the bones most frequently fractured as a result of indirect, or blowout, fractures.

Floor of the orbit – It is composed of the maxillary, palatine, and zygomatic bones**.** It forms the roof of the maxillary sinus; and does not extend to the orbital apex but instead ends at the pterygopalatine fossa; hence, it is the shortest of the orbital walls. Important landmarks: the infraorbital groove and infraorbital canal, which transmit the infraorbital artery and the maxillary division of the trigeminal nerve. As the floor is thin, a tumor or empyema of the maxillary antrum can easily affect the orbit.

Lateral wall of the orbit – It is composed of the zygomatic bone and the greater wing of the sphenoid; separated from the lesser wing portion of the orbital roof by the superior orbital fissure. Important landmarks: the lateral orbital tubercle of Whitnall, with multiple attachments, including the lateral canthal tendon, the lateral horn of the levator aponeurosis, the check ligament of the lateral rectus, the Lockwood ligament, and the Whitnall ligament; and the frontozygomatic suture, located 1 cm above the tubercle.

Superior orbital fissure -It separates the greater and lesser wings of the sphenoid and transmits cranial nerves III, IV, and VI; the first (ophthalmic) division of cranial nerve (CN) V; and sympathetic nerve fibers. Most of the venous drainage from the orbit passes through this fissure by way of the superior ophthalmic vein to the cavernous sinus.

Inferior Orbital Fissure- It is bounded by the sphenoid, maxillary, and palatine bones and lies between the lateral orbital wall and the orbital floor. It transmits the second (maxillary) division of CN V, including the zygomatic nerve, and branches of the inferior ophthalmic vein leading to the pterygoid plexus. The infraorbital nerve, which is a branch of the maxillary nerve enters the orbit at the infraorbital groove and travels anteriorly in the floor of the orbit through the infraorbital canal, emerging on the face of the maxilla 1 cm below the inferior orbital rim. The infraorbital nerve carries sensation from the lower eyelid, cheek, upper lip, upper teeth, and gingiva. Numbness in this distribution often accompanies blowout fractures of the orbital floor.

Zygomaticofacial and Zygomaticotemporal Canals- They transmit vessels of the zygomatic nerve through the lateral orbital wall to the cheek and the temporal fossa.

Nasolacrimal Canal - The nasolacrimal canal extends from the lacrimal sac fossa to the inferior meatus beneath the inferior turbinate in the nose. Through this canal passes the nasolacrimal duct, which is continuous from the lacrimal sac to the nasal mucosa**.**

Optic canal (foramen) - It is 8-10 mm long and is located within the lesser wing of the sphenoid. The optic nerve, ophthalmic artery, and sympathetic nerves pass through this canal. The orbital end of the canal is the optic foramen, which normally measures less than 6.5 mm in diameter in adults.

Extra Ocular Muscles: include four recti and two oblique muscles which control eye movements. The rectus muscles arise from the annulus of Zinn which is a funnel-shaped tendinous ring that encloses the optic foramen and medial end of superior orbital fissure. The superior oblique originates from the periosteum of the body of the sphenoid bone, above and medial to the annulus of Zinn, and the origin of the medial rectus. The inferior oblique is the only extraocular muscle that originates from the orbital apex but forms a shallow depression in an orbital plate of the maxilla at the anteromedial corner of the orbital floor just posterolateral to the orifice of the nasolacrimal duct.

Optic Nerve*:* It is about 3.5 to 5.5 cm long and about 3 to 4mm in diameter[5]. It is divided into four parts. a. Intraocular b. Intraorbital c. Intracanalicular d. Intracranial.

Intraocular part: It is about 1 mm long and 1.5 mm in diameter. Its anterior surface represents the visible optic disc in the ocular fundus.

Intraorbital part: It begins as the optic nerve head exits the sclera and extends to the orbital opening of the optic canal, measuring about 2-3 cm in length and 3-5 mm in diameter.

Intracanalicular part: It measures about 9 mm in length. Its orbital opening is elliptical with the widest diameter oriented vertically. The intracranial opening is also elliptical but with the widest diameter oriented horizontally.

Intracranial part: It varies in length from 3 to 16 mm and measures about 4.5 mm in great diameter.[6]

Blood Vessels of the Orbit

Arterial Circulation- Mainly ophthalmic artery – a branch of the internal carotid artery. The infra-orbital artery is a branch of the maxillary artery, a branch from the middle meningeal artery. Ophthalmic artery branches are central retinal artery, long and short posterior ciliary arteries, muscular arteries, lacrimal artery, supraorbital artery, ethmoidal arteries, meningeal branch, supratrochlear, dorsal nasal and palpebral arteries.

Venous Circulation- The three veins are the superior ophthalmic vein, the inferior ophthalmic vein, and the central retinal vein. The venous outflow has three directions a) Anteriorly to the angular and facial veins b) Posteriorly to the cavernous sinus c) Inferiorly to the pterygoid plexus of veins

Orbital Lymphatics- Ocular tissues that comprise lymphatics are found in eyelids, bulbar conjunctiva, lacrimal gland, optic nerve sheath, extraocular muscles, cones, and choroid (avian eyes)[7].

Nerves of the Orbit

· Optic nerve

· Motor nerves i) III cranial nerve supplies the medial, superior, and inferior rectus and inferior oblique. Parasympathetic to the intraocular muscles conveyed through ciliary ganglion. ii) IV cranial nerve supplies the superior oblique. iii) The VI cranial nerve supplies the lateral rectus.

· Sensory nerves: First and second divisions of trigeminal nerves.

· Sympathetic nerves: To the eyeball, lacrimal gland, vessels, and smooth muscles of the orbit.

· Secreto-motor nerve: To the lacrimal gland, from the VII nerve (greater superficial petrosal nerve), communicated via sphenopalatine ganglion.

· Ganglion: Ciliary ganglion with its sensory, motor, and sympathetic roots and the short ciliary nerves given off to the eyeball [4, 8, 9]

The incidence of orbital trauma reported in the literature was through studies by Kennedy [10] (13%), Rootman (4.9%), Dallow (2%), and Subrahmanyam (4.9%) [1].

In an analysis of 28,340 trauma admissions in the 2003-2007 National Trauma Data Bank National Sample Program by Scruggs and colleagues, the most common ocular injuries were contusions and then closed orbital fractures accounting for 0.95% to 2.48% and 0.58% to 2.37% of all injuries respectively. Facial fracture-related procedures were reported between 0.16% and 0.65% of all trauma patient admissions[11].

Yadav K studied 6 clinical predictors that identify patients with blunt orbital trauma at increased risk for acute orbital fractures in 2262 patients. They are orbital rim tenderness, periorbital emphysema, and subconjunctival hemorrhage, pain with extraocular movement, impaired extraocular movement, and epistaxis. Acute orbital fractures were found in 15.9%. A mean of 29.2% lacked all 6 equally weighted predictors, of which 6.3% developed acute orbital fractures[12]. Vaca stated that penetrating injury mechanism and zone of eye injury appear to be better indicators of visual prognosis than facial fracture patterns. Orbital fracture repair should not be delayed in the hope of eventual visual recovery in cases of high-velocity projectile trauma[13].

Degala studied that road traffic accidents were the most common cause of orbital fractures which correlated with our study (64.7%) [14].

In our study, single-wall fracture was the most common type (70.5%) followed by complex combined fractures. Barta and Schubert [15] studied that 60.3% were simple lateral orbital wall fractures (LOWF) and the remaining 39.7% were comminuted LOWF. Biegi B classified orbital floor fractures into a trap door and non-trap door type and concluded that the latter had a successful outcome with a delayed repair[16].

Our study showed that medial wall and floor were commonly involved (29.4% each) followed by lateral wall (23.5%) and roof (5.8%). Boffano[17] and colleagues studied 447 patients with orbital blowout fractures and identified that the floor was the most common site (80.3%) followed by medial wall (9.1%) and lateral wall (1.1%). This can be explained due to the thinness of the bone of the medial wall and floor of the orbit, which gives way when the intraorbital pressure is raised due to trauma. 29.4 % of cases in the present study had evidence of diplopia while Boffano's study showed 50.7%.The prevalence of diplopia is found to be less than that of ocular motility restriction (76.4%). This is because diplopia in extreme gazes does not inconvenience the patient and hence is usually ignored.

Minoru Furuta[18] studied 113 cases of pure blow-out orbital fractures with diplopia and concluded that the clinical manifestations and prognosis of patients were approximately predicted through the analysis of CT on fracture type and number of points of contact of an extraocular muscle to fracture edge. Tsao K and co-workers studied the role of cone beam CT (CBCT) in the postoperative evaluation of orbital wall fractures[19].

Studies by Ropposch[20], Yu-Wai-Man, and Griffiths[21] analyzed that steroids did not have any beneficial effect on the visual outcome in patients of traumatic optic neuropathy (TON). The present study does not go by the above study as all except 1 patient with traumatic optic neuropathy having no PL showed significant improvement in vision with pulse steroids.

Wang BH[22] studied 61 patients of visual loss following facial trauma over 12 years and analyzed that patients with penetrating trauma had worse outcomes than blunt trauma. Improvement in visual outcome was seen in 19% of penetrating trauma and 45% of blunt trauma. Among the patients with blunt trauma, 83% of patients without orbital fractures showed improvement compared to 38% of patients with orbital fractures. The presence of no light perception and an orbital fracture are poor prognostic factors for visual loss following blunt trauma.

In the present study, all cases of fractures showed improvement apart from the one with no light perception (Fig1 and Fig 2). The maximum improvement occurred from CF 2 m to 6/6 following fracture floor repair and removing the bone spiculum and from CF 3m to 6/6 following IV pulse steroids. One patient who had no light perception at presentation did not improve with pulse steroids.

Limitations of the present study

1. The study sample was small.

2. Requires a multi-disciplinary approach which is not always feasible in the same hospital.

3. Investigations like CT scans are very costly

4. Orbital fractures require long-term follow-up.

5. Low socioeconomic status, poverty, and illiteracy among patients lead to poor compliance in utilizing the treatment facilities, and in follow-up.

CONCLUSIONS

Adult Males were commonly involved in orbital fractures, the main etiology being RTA. CT scan is a good investigative tool in locating the orbital fractures. Non-surgical management was the most common method adopted. The present study reveals that timely referral early diagnosis and appropriate management can result in visual improvement and improvement in extraocular motility. A disciplinary diagnostic and therapeutic approach were needed.

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