

Original Research Article

Treatment of orbital floor fractures in a reference center in Mexico city

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ABSTRACT

Background: Orbital trauma accounts for approximately 3% of all emergency department visits, with approximately 4.4 million annual visits in the United States alone. We aim to describe the treatment of adult patients with orbital floor fractures between 2016 and 2021.

Methods: A retrospective, descriptive, cross-sectional, and observational study was conducted on the medical records of adult patients with orbital floor fractures between 2016 and 2021 in a referral center in Mexico city.

Results: The study included 53 patients, 5 females (8%) and 48 males (92%), with a median age of 37 years at the time of diagnosis. Among the reported trauma mechanisms, falls and violence were the most common. 4 patients (7.5%) had impure right unilateral fractures, 4 patients (7.5%) had impure left unilateral fractures, 18 patients (33.9%) had pure left unilateral fractures, 22 patients (41.5%) had pure right unilateral fractures. Five patients (9.4%) had pure bilateral fractures. Six (11.3%) received non-surgical treatment, while 47 (88.6%) underwent surgical treatment. The most common surgical approach was the transconjunctival with lateral extension.

Conclusions: There was a predominance of male patients and physical aggression as the primary trauma mechanism. Automated vehicle accidents were associated with more complex fractures. The most common type of orbital floor fracture was pure right unilateral. Most patients underwent open reduction with internal fixation.

Keywords: Orbit floor, Open reduction with internal fixation, Open reduction without internal fixation, Osteosynthesis material, Absorbable material

INTRODUCTION

Orbital trauma accounts for approximately 3 percent of all emergency department visits, with approximately 4.4 million annual visits in the United States alone. A study conducted at the "Dr. Manuel Gea González" General Hospital showed that 35 percent of patients over 65 years of age who visited the Plastic and Reconstructive Surgery department had orbital floor fractures, making it the most common type of orbital fracture.¹

The orbit is a bony pyramid connected by the roof, floor, medial wall, and lateral wall, with the orbital opening forming the pyramid's base. The orbital floor, which

forms the maxillary sinus roof, slopes upward toward the pyramid's apex, located approximately 44 to 55 mm posterior to the orbital entrance. The total volume of the bony orbit is approximately 30 ml, with the eyeball occupying 7 ml, which can vary by gender and race.²

The bony orbit protects the eyeball and is commonly affected in most mid-facial fractures. Fractures of the orbital rim and floor are often associated with fractures of the zygomatico-maxillary complex. When the orbital floor is involved, it is called a "Blowout" fracture.

In most cases, orbital floor fractures are associated with fractures of the inferior orbital rim, referred to as

"impure," when the inferior orbital rim is not affected; it is referred to as "pure." The latter can be found in 22 to 47 percent of cases.³

"Pure" orbital floor fractures were first described by Lang in 1889. In 1901, Rene Le Fort concluded that blowout fractures occur due to the transmission of forces from the rigid inferior orbital rim to the relatively weaker orbital floor, known as the "bowing" theory. It was not until 1948 that Pfeiffer observed the existence of blowout-type orbital floor fractures in patients with direct ocular trauma, which he termed the "hydraulic" theory. This theory suggests that pressure on the eyeball is transmitted to the bony orbit, resulting in a fracture of the thin orbital floor.^{4,5}

The most common signs and symptoms of orbital floor fractures include localized pain, diplopia (double vision), periorbital ecchymosis (bruising around the eye), eyelid swelling, subconjunctival hemorrhage, and sensory deficits in the distribution of the infraorbital nerve. The physical examination should begin with inspecting the orbit and periorbital area. Any lacerations or bony steps should be analyzed, as well as the presence of enophthalmos (posterior displacement of the eyeball) or dystopia (misalignment of the eye).^{4,6}

Visual acuity and color perception should be evaluated, as this provides insight into optic nerve involvement, with the loss of color saturation, especially red, being an early sign of traumatic optic neuropathy. The pupillary examination is crucial in assessing size, symmetry, and photomotor and consensual reflexes.

CT (computed tomography) is the gold standard for imaging evaluation of orbital floor fractures. Advances in technology have allowed for 1-2mm coronal and sagittal cuts and reconstructions, which have proven to be the most useful. CT evaluation provides reliable information about the defect's size, the eyeball status, extraocular muscles, and evidence of entrapment.⁴

The most important factors to consider in choosing an ideal treatment for patients with orbital floor fractures are enophthalmos, ocular mobility, and radiographic findings. Imaging reports indicating involvement of more than 50 percent of the floor or areas larger than 1 to 2 cm² are significant.^{4,5}

The primary goal of orbital floor reconstruction is to release tissue entrapment and restore orbital anatomy and volume.^{4,5}

The surgical indications for orbital fractures are controversial. Some absolute and immediate indications, defined within the first 24 to 48 hours, include enophthalmos greater than 2 mm, defects larger than 2 cm, muscle entrapment, oculocardiac reflex triggered by increased intraocular pressure or the soft tissue entrapment.⁵

Patients who present without findings requiring immediate treatment should be followed up within two weeks to assess symptom progression or lack of resolution. If surgical treatment is eventually needed, it is referred to as delayed treatment. Typically, these patients present with infraorbital nerve hypoesthesia, diplopia, and enophthalmos.³

There are different approaches for the treatment of orbital floor fractures: -Subtarsal, infraorbital, transconjunctival, transconjunctival with lateral extension and transcaruncular.

Most surgeons have abandoned the subciliary incision as it has shown a high risk of cicatricial ectropion (outward turning of the eyelid). The subtarsal approach provides direct access to the orbital floor and is technically less demanding but leaves a visible scar. The transconjunctival approach has been studied in more detail and has a low rate of complications while leaving no visible scar. However, in most cases, this approach requires lateral canthotomy for better exposure of the structures and carries a minimal risk of entropion (inward turning of the eyelid) development.^{3,7}

A literature review has shown a continuous increase in the use of the transconjunctival approach over the past ten years, accompanied by a simultaneous decrease in the infraorbital approach.⁶

As mentioned earlier, the primary goal of surgical treatment is to restore anatomy and stability to the orbital floor. The materials used for reconstruction can be broadly divided into two categories: Biological and alloplastic.

Biological materials

Various biological materials, such as autologous bone and cartilage grafts, can be used for orbital floor reconstruction. Autologous bone remains the gold standard for orbital floor reconstruction. It provides rigidity, moldability, vascularity, biocompatibility, and minimal immune response. The disadvantage associated with bone harvesting is donor site morbidity. Options for donor sites include the iliac bone, rib, and calvaria, with the latter being available in full or partial thickness.^{3,8,9}

Autologous cartilage grafts have favorable applications as they are easily obtained, malleable, provide sufficient support, and show no evidence of resorption. They are occasionally used for minor defects and are primarily harvested from the auricular concha and nasal septum.⁸

Another alternative is allografts, including lyophilized dura mater and lyophilized human bone.

Broadly, alloplastic materials can be divided into absorbable and non-absorbable categories:

Absorbable materials

Absorbable polymers have been used for over 30 years in various surgical fields. They can be easily molded to provide the ideal size and shape. The goal of these materials is to provide temporary support while fibrous granulation tissue forms as they degrade. Components used include poly-L-lactic acid, polyglycolic acid, polydioxanone, and a combination of poly-L-lactic acid and polyglycolic acid. These materials are beneficial for pediatric patients.^{8,14}

Non-absorbable materials

Permanent alloplastic materials offer long-term rigidity but have a higher risk of material-related infections. Porous polyethylene allows for the growth of fibrous and vascular tissue within the openings of its pores, with the advantage of easy molding and adaptation. However, it can potentially adhere to exposed extraocular muscles, so it is not recommended in these cases.^{3,8,10}

Titanium meshes have been alloplastic material for orbital floor reconstruction since 1990. They are typically used in cases with significant defects and correction of ocular malposition. The advantages include their availability, biocompatibility, malleability, and rigid fixation. Currently, new materials combine titanium with a porous polyethylene coating, which offers the advantages of both materials.^{3,8,12}

Other materials are available for orbital floor reconstruction, such as silicone, nylon, or Teflon.^{8,12}

Two studies found that most surgeons used absorbable alloplastic materials.^{10,11}

The most common complications in patients after orbital floor reconstruction surgery are persistent diplopia (double vision), dysfunction of the infraorbital nerve, and enophthalmos (posterior displacement of the eyeball).

The range of persistent diplopia varies from 20% to 52%. It has been shown that the incidence of persistent diplopia is lower in patients with early treatment than in patients with delayed treatment.^{13,15} Persistent diplopia is also associated with the persistence of muscle edema, neuropathy or compression, and soft tissue entrapment. There is an association between the persistence of diplopia and the use of the porous titanium meshes.¹⁷

Dysfunction of the infraorbital nerve can manifest as hyperesthesia or paresthesia and has been reported as the most common complication in up to 55 percent of patients.¹³

Enophthalmos, while common in patients, is the most concerning complication. An incidence of up to 27.5% has been described. This condition can be caused by orbital tissue prolapse into the sinus cavity, increased

orbital volume, fat atrophy, or loss of orbital support.^{13,15,16}

Orbital floor fractures are considered one of the most commonly encountered problems in emergency departments, making knowledge of evaluation, treatment, and complications a fundamental pillar.

METHODS

A retrospective, descriptive, cross-sectional, and observational study was conducted on medical records of adult patients of both sexes with orbital floor fractures from 2016 to 2021 under the purview of the division of plastic and reconstructive surgery at Dr. Manuel Gea González general hospital. The study was approved by the institutional review board (IRB) and informed consent was obtained from each patients.

The sample size for this study was determined by including all patients with a diagnosis of orbital floor fracture who received treatment at our hospital. In this approach, the entire population of patients with orbital floor fractures at the specified hospital was considered, eliminating the need for a specific sample size calculation

Information was collected from patient records, progress notes, consultation notes, and surgical notes. The mechanism of injury and type of fracture, whether it was unilateral or bilateral, pure or impure, according to the classification for orbital floor fractures, were analysed. The treatment administered to these patients, either conservative or surgical, and the materials used in surgical cases were also analysed.

Inclusion criteria comprised complete medical records of adult patients of both sexes treated at this hospital with a diagnosis of orbital floor fracture protocolized by the orthognathic surgery and facial trauma clinic within the plastic surgery department between the year 2016 and 2021.

Exclusion criteria included medical records of adult patients with a diagnosis of orbital floor fracture treated in the plastic and reconstructive surgery department of Dr. Manuel Gea González general hospital with incomplete records or lacking necessary information.

A descriptive analysis of the variables was conducted using measures of central tendency (mean, median) and dispersion (standard deviation) for continuous variables and percentages for qualitative variables.

RESULTS

Demographic characteristics

The study included fifty-three patients, five females (8%) and forty-eight males (92%), with a median age of thirty-seven years (range 26 to 91 years) at the time of the

orbital floor fracture diagnosis. Among the reported mechanisms of trauma, falls and violence were the most common, with forty-three patients experiencing violence (81.1%), eight patients experiencing falls (15.09%), followed by motor vehicle accidents with two patients (3.7%).

Type of fracture

All patients evaluated by the plastic and reconstructive surgery service with suspected facial fractures undergo computed tomography with three-dimensional reconstruction.

According to the described classification of orbital floor fractures, it was found that out of the fifty-three patients who met the criteria, the most common types were as follows: 18 patients (33.9%) had a pure left unilateral fracture, 22 patients (41.5%) had a pure right unilateral fracture, four patients (7.5%) had an impure right unilateral fracture, four patients (7.5%) had an impure left unilateral fracture, and five patients (9.4%) had a pure bilateral fracture.

Treatment

All patients were evaluated, and depending on clinical findings and fracture characteristics, they were divided into two main groups: Surgical and conservative treatment.

The non-surgical group represented 6 patients (11.3%) in this study, as they did not meet surgical criteria based on their clinical assessment and fracture characteristics.

Among the surgical treatment group, 44 patients (83%) underwent open reduction with internal fixation, and three (5.6%) underwent open reduction without internal fixation.

Within the group of patients who underwent open reduction with internal fixation, exclusively absorbable material was used in 17 patients (32%), absorbable material with fixation using self-drilling titanium screws in 22 patients (41.5%), absorbable material with titanium plate fixation for impure fractures in 4 patients (7.5%), and autologous tissue, specifically auricular cartilage, was used in 3 patients (5.6%).

Only one patient (1.85 percent) underwent titanium mesh reconstruction due to the size of the orbital floor defect.

Regarding the previously described approaches, out of the 44 patients who underwent surgical treatment, 33 patients (62.2%) underwent the transconjunctival approach with lateral extension, 12 patients (22.6%) underwent transconjunctival without lateral extension, and only two patients (3.7%) underwent the subciliary approach.

Table 1: Demographic characteristic and results.

Gender	N	Percentages (%)
Man	48	90.5
Women	5	9.4
Total	53	
Treatment		
Surgical	47	88.6
Not surgical	6	11.3
Total	53	
Mechanism of injury		
Violence	43	81.1%
Falls	8	15.09
Motorized vehicle	2	3.7
Type of fracture		
Bilateral	5	9.4
Pure left unilateral	18	33.9
Pure right unilateral	22	41.5
Impure left unilateral	4	7.5
Impure right unilateral	4	7.5
Type of treatment		
Open reduction with internal fixation	44	83.01
Open reduction without internal fixation	3	5.6
Surveillance	6	11.3
Material		
Absorbable	17	32.07
Absorbable + self-drilling screw	22	41.5
Absorbable + titanium plate	4	7.5
Autologous	3	5.6
Titanium mesh	1	1.8
Surgical approach		
Transconjunctival with lateral extension	33	62.2
Transconjunctival	12	22.6
Subciliar	2	3.7

DISCUSSION

This retrospective study included 53 patients during the described periods; orbital floor fractures require a comprehensive patient evaluation and a well-established protocol for optimal management. Plastic and reconstructive surgery and the orthognathic surgery and facial trauma clinic evaluated patients in this study. All patients underwent computed tomography with three-dimensional reconstruction, as described in the literature, which is considered the gold standard.³

Regarding epidemiology, the average age of 37 years, male predominance, and the most common mechanism of trauma being physical assault align with international literature.¹⁰

Among the patients who underwent open reduction with internal fixation, which accounted for 83% of the sample,

absorbable material was used in 81.7%, consistent with the most commonly used material in currently available publications.^{10,11}

Consistent with international literature, the least utilized approach is the subciliary route, which corresponds to our center's practice due to its higher risk for secondary cicatricial ectropion.^{3,7}

The incision for surgical approach must allow for the assessment of all structures and the defect to be repaired without causing or leaving any functional or aesthetic alterations. Some authors argue that the transconjunctival approach does not allow for the complete evaluation of structures; however, the lateral extension allows for the comprehensive evaluation of all structures to be repaired. Given this, the transconjunctival approach with lateral extension was the most commonly used in the presented sample, which, according to various publications, has seen an increase in its use as the preferred approach in the last decade.⁶

Limitations

Despite the valuable insights provided by this study on the treatment of adult patients with orbital floor fractures, certain limitations should be acknowledged. Firstly, the retrospective nature of the study design poses inherent challenges, including potential selection bias and incomplete documentation in medical records. The reliance on data from a single institution, the general hospital "Dr. Manuel Gea González", may limit the generalizability of the findings to a broader population. Additionally, the study's focus on a specific time frame (2016-2021) may not fully capture evolving trends or changes in treatment protocols over a more extended period. The sample size of 53 patients, while informative, may restrict the ability to detect rare outcomes or variations in treatment responses. Despite these limitations, the study contributes valuable information to the understanding of the demographic characteristics and treatment patterns of adult patients with orbital floor fractures within the specified hospital setting.

CONCLUSION

This study provides an epidemiological overview and treatment description in the plastic surgery department of our hospital. There is a significant male predominance and physical assault as the primary trauma mechanism. Accidents involving motor vehicles are associated with more complex fractures. Regarding the classification of orbital floor fractures, pure right unilateral fractures represent the most common type. Most patients underwent open reduction with internal fixation, with absorbable material and self-tapping screw fixation being the most commonly used, along with the transconjunctival approach with lateral extension.

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