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Retrospective analysis of 301 patients with orbital floor fracture

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A B S T R A C T

The purpose of this study was to retrospectively analyse patients with orbital floor fracture who were treated at the Department of Odontostomatology and Maxillofacial Surgery, Policlinico Umberto I, Sapienza University of Rome, Italy, between 2008 and 2013. Patients were evaluated by age, sex, aetiology, clinical findings, fracture pattern, ocular injury, treatment, complications, and sequelae. We evaluated surgical outcomes and complications with the use of different surgical approaches and various materials used to reconstruct the orbital floor. In total, there were 301 orbital fractures. Two hundred and seventeen patients were men (72.1%) and 84 were women (27.9%). The average age of the patients was 37.2 years (range, 9–90 years). The leading cause of these fractures was violent assault (27.3%). Pure blow-out fractures (50.2%) were the most represented pattern, followed by zygomatic complex (46.5%). The most common symptom was hypoesthesia extending through the territory of the second trigeminal branch (TBH; 32.9%). Diplopia was present in 20.2% of patients followed by enophthalmos (2.3%) and extraocular movement limitation (1.7%). Ocular symptoms significantly improved following surgical repair. The most common postoperative complications included TBH in 34.2%, scarring 26%, and diplopia in 16.4% of the patients.

1. Introduction

Orbital wall fractures are classified as isolated fractures, involving a single orbital wall, or as combined fractures, when more than 1 orbital wall is involved. The floor is the most frequently injured of the 4 orbital walls because it contains the largest open space and lacks support; thus, it is often fractured following blunt orbital and facial traumas. The frequency of orbital floor fractures is becoming more common owing to the increasing number of traffic accidents, industrial accidents, sport-related injuries, and physical assaults (Shin et al., 2013). More rarely, orbital floor fractures are the result of a gunshot wound or fall (Piombino et al., 2010).

These fractures may cause significant functional and cosmetic complications, such as hypoesthesia extending through the territory of the second trigeminal branch (TBH), diplopia, enophthalmos, restriction of ocular motility, and ocular injuries. Orbital floor fractures can be classified as pure or impure blowout fractures: the former are isolated orbital floor fractures, while the latter are also associated with orbital rim fracture involving other contiguous bones (maxillary, zygomatic, nasoethmoidal, or frontal) (Tong et al., 2001).

In the literature, there are several discordant studies regarding the epidemiological, clinical, and demographic characteristics of patients, type of surgical approach, implant materials, and surgical timing when it comes to orbital floor fractures.

We evaluated clinical and epidemiological findings, surgical techniques, surgical outcomes, and the association between type of surgical approach incision and material used for reconstruction and complications.

2. Materials and methods

We retrospectively reviewed the charts of 301 patients with surgically treated orbital floor fractures at the Department of Odontostomatology and Maxillofacial Surgery, Policlinico Umberto I, Sapienza University of Rome, Italy, between 2008 and 2013. Patients who had previous surgical treatment, or who had additional bone fractures, were excluded.

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Patients were evaluated by age, sex, aetiology, symptoms, co-morbidity, clinical findings, fracture pattern, ocular injury, treatment, time of operation after trauma, complications, and sequelae. Diplopia, enophthalmos, restriction of ocular motility, and ocular injuries were determined in association with ophthalmologists.

Computed tomography (CT) was performed before surgery to classify the orbital fractures and to choose the most suitable reconstruction method, as well as postoperatively to verify surgical outcome.

3. Results

Of the patients, 217 were male (72.1%) and 84 were female (27.9%). The average age of the patients was 37.2 years (range, 9–90 years). Patients were divided into 8 groups according to age (10-year intervals), with a separate group to include paediatric patients (0–14 years): 6 patients (1.9%) were younger than 14 years, 84 patients (27.9%) were between 15 and 24 year of age, 79 (26.2%) between 25 and 34-year range, 44 (14.6%) between 35 and 44 years, 38 (12.6%) between 45 and 54 years, 25 (8.3%) between 55 and 64 years, 15 (4.9%) between 65 and 74 years, and 10 patients (3.3%) were older than 75 years. Orbital floor fractures were most often seen in 15- to 24-year-old men (88 patients, 66 male and 14 female; Table 1). The majority of patients in the <64-year age groups were male (210 male and 66 female), although here was a significant prevalence of female patients >65 years of age (7 male and 18 female).

Pure blow-out fractures (50.2%) were the most highly represented pattern, followed by zygomatic complex (46.5%). The most common symptom was hypoesthesia extending through the territory of the TBH (32.9%). Diplopia was present in 20.2% of patients, followed by enophthalmos (2.3%) and extraocular movement limitations (1.7%).

The principal aetiology of orbital floor fractures was violent assault ($n = 82$; 27.3%), followed by traffic accidents ($n = 75$; 24.9%), falling or slipping ($n = 40$; 13.3%), sports-related injury ($n = 31$; 10.3%), domestic accidents ($n = 15$; 4.9%), accidents at work ($n = 10$; 3.3%), struck by a horse hoof ($n = 2$; 0.7%), and ballistic trauma ($n = 1$; 0.3%; Table 2).

We report a number of patients ($n = 45$; 14.9%) for whom the cause of trauma was undetectable because of history biases or because it was not declared. Violent assault was the most common cause in male patients, whereas traffic accidents was the most common in female patients; falling or slipping was the most frequent cause in patients >75 years of age.

Right pure blow-out fractures occurred in 69 patients (22.9%), left blow-out fractures in 76 patients (25.2%), and bilateral orbital floor involvement was evident in 6 patients (1.9%); 2 patients had unilateral impure blow-out fractures (0.6%). A total of 66 patients (21.9%) had unilateral right orbito-maxillo-zygomatic fracture, and 74 patients (24.6%) had unilateral left orbito-maxillo-zygomatic fracture. Five patients (1.6%) presented with orbital floor fracture in a Le Fort II pattern, and 3 patients (0.9%) with complex facial fractures.

Table 1
Age distribution of patients.

Age range	Patients, N (%)
0–14	6 (1.9%)
15–24	84 (27.9%)
25–34	79 (26.2%)
35–44	44 (14.6%)
45–54	38 (12.6%)
55–64	25 (8.3%)
65–74	15 (4.9%)
>75	10 (3.3%)
Total	301

Table 2
Percentage of aetiology.

Aetiology	Patients, N (%)
Violent assault	82 (27.2%)
Traffic accident	75 (24.9%)
Falling/Slipping down	40 (13.3%)
Sports injury	31 (10.3%)
Domestic accident	15 (4.9%)
Works accident	10 (3.3%)
Horse's hoof	2 (0.7%)
Ballistic trauma	1 (0.3%)
Undetectable cause	45 (14.9%)

In 13 patients (4.3%), the orbital floor fracture was accompanied by systemic injuries: 5 patients had polytrauma, 6 had cerebral trauma, and 2 had fractures of other skeletal elements.

Ophthalmological examination findings included monocular visual disturbances ($n = 3$; 0.9%), while dystopia, lagophthalmos, deficit of the facial nerve, and subcutaneous emphysema were noted in 1 patient each ($n = 1$; 0.3%).

Clinical and radiographic analysis revealed 18 patients with concomitant facial wounds, and 36 patients with associated facial fractures (31 nasal bones fractures, 3 mandible fractures, 1 sinus frontal fracture, and 1 Le Fort I type fracture).

The most common clinical signs and symptoms were hypoesthesia extending through the territory of the TBH ($n = 99$; 32.9%), diplopia ($n = 61$; 20.2%), enophthalmos ($n = 7$; 2.3%), and extraocular movement limitation ($n = 5$; 1.7%). Multiple symptoms were found in 24 patients (7.9%): 18 patients (6%) had TBH and diplopia, 4 patients (1.4%) had TBH and enophthalmos, and 2 patients (0.6%) had enophthalmos and diplopia.

Clinical follow-up was performed at 1 week, 2 weeks, 3 months, and 6 months after treatment.

The mean $\pm$ standard deviation of time interval between trauma and surgery was 3 ± 4 days.

Reconstruction of the orbital floor was performed in all cases. The surgical approach was through a lower eyelid incision in 231 patients (76.7%), a lower transconjunctival incision in 43 patients (14.3%), a contextual-wound approach in 16 patients (5.3%), a subciliar incision in 8 patients (2.6%), and an incision through a previous scar in 1 patient (0.3%).

Restoration of orbital floor integrity was performed by using resorbable implants (bovine pericardium membrane, TUTOPATCH™) in 180 patients (59.8%), heterologous bone-graft in 86 patients (28.6%), screw-fixed heterologous bone-graft in 14 patients (4.6%), screw-fixed titanium mesh associated with resorbable implant in 6 patients (1.9%), titanium mesh associated with resorbable implant in 4 patients (1.3%), screw-fixed titanium mesh in 3 patients (1%), heterologous bone-graft associated with resorbable implant in 3 patients (1%), and titanium mesh in 2 patients (0.7%). No material was used after reduction of the fracture in 3 patients (1%).

Postoperative complications occurred in 115 patients (38.2% of the sample). Immediately after surgery, 45 patients (39.1%) had TBH, 22 patients had diplopia (19.1%), 4 patients complained about the scar outcome (3.4%), 2 patients (1.7%) showed extraocular movement limitations, and 2 cases had residual enophthalmos (1.7%; Table 3).

Of 115 patients, 73 (63.4%) had persistent complications after 6 months: 25 (34.2%) TBH, 19 (26%) scar outcome, and 12 (16.4%) diplopia.

Table 3
Percentage of postoperative complications.

Postoperative complication	Patients, N (%)
TBH	45 (39.1%)
Diplopia	22 (19.1%)
Scar outcome	4 (3.4%)
Extraocular movement limitation	2 (1.7%)
Enophthalmos	2 (1.7%)
Total	115

Of 24 patients with multiple preoperative complications, after 6 months 7 patients (29.1%) had residual TBH and diplopia and 3 patients (12.5%) with preoperative enophthalmos and TBH had persistent TBH.

Reoperation was performed successfully in 2 patients (0.6%): in 1 case for religious reasons, due to a communication problem (he did not understand the origin of swine bone allograft), and the second due to improper implant positioning.

Comparing the different types of surgical approach in the sample, we calculated the occurrence of presence (Y) or absence (N) of complications based on the type of incision performed. Thus, we excluded patients <14 years and >65 years of age, divided them according to gender, and selected only those patients who were treated with the most common resorbable implant (bovine pericardium membrane).

Complications in the male group were as follows: 100% with a subciliar approach, 40% with a trough-injury approach, 31.1% with lower eyelid incision, and 30.6% with a transconjunctival approach.

The complications in the female group were as follows: 50% with subciliar incision, 44.4% with a transconjunctival approach, and 43.3% in patients treated with lower eyelid incision.

A comparison between various implant materials used was performed in a similar way: we selected middle-aged patients, divided them according to gender, and selected only those patients that who were treated with the most common surgical approach (lower eyelid) and the most commonly used implant materials (heterologous bone graft and resorbable mesh).

Complications in the male group treated with lower eyelid incision included 71 patients (resorbable mesh; 68.9%) and 23 patients (heterologous bone graft; 63.9%).

Complications in the female group treated with lower eyelid incision were 56.2% (resorbable mesh) and 46.2% (heterologous bone graft).

4. Discussion

Orbital floor fractures usually occur as a result of blunt orbital and facial trauma. Of the 4 walls of the orbit, the floor is the most frequently injured due to its open structure and lack of support. These fractures are becoming more frequent because of the increasing number of traffic accidents, industrial accidents, sport-related injuries, and physical assaults (Shin et al., 2013). More rarely, orbital floor fracture can be the result of a gunshot wound or fall (Piombino et al., 2010).

These fractures may cause severe functional and cosmetic complications, including, but not limited to, infraorbital nerve dysaesthesia, diplopia, enophthalmos, extraocular movement limitations, and ocular injuries. Fractures of the orbital floor that do not cause functional or aesthetic injuries do not normally require surgical treatment.

In the literature, there are several contradictory studies regarding the epidemiological, clinical, and demographic characteristics of patients, type of surgical approach, implant materials, and prompt time to perform surgery, when it comes to orbital floor fractures.

The patients in our study were evaluated by age, sex, aetiology, symptoms, comorbidity, clinical findings, fracture pattern, ocular injury, treatment, time to surgery after trauma, complications, and sequelae. In our department, we reviewed 301 patients with surgically treated orbital floor fractures, and excluded patients who had previous surgical treatment or who had other bone fractures. CT scans were performed before surgery to classify the orbital fractures and to choose the most suitable reconstruction approach, as well as during the postoperative period to verify surgical outcome.

Overall, 217 patients were men (72.1%) and 84 were women (27.9%), and the average age of the patients was 37.2 years (range, 9–90 years). In our report, the ratio of male to female patients was about 2.5:1, with the highest prevalence in the 15- to 24-year age group (27.9%) and the 25- to 34-year-old group (26.2%), whereas the incidence of these fractures in patients <14 years was only of 1.9% (6 patients); these findings support the results of previous studies (Tong et al., 2001; Cruz and Eichenberger, 2004; Shin et al., 2013; Hoppe et al., 2014).

The majority of patients in the <64-year age group were male (210 men), although there was a significant prevalence of female patients experiencing fractures who were >65 years of age (7 men and 18 women).

The leading cause of all fractures was violent assault ($n = 82$, 27.3%), which is consistent with the results of several other studies (Tong et al., 2001; Chi et al., 2010; Eun et al., 2007; Shin et al., 2013). Shin et al. reported the second most common cause of orbital fractures as fall/slip, followed by traffic accidents (Shin et al., 2013); conversely, in our study, traffic accident ($n = 75$, 24.9%) was the second most common cause, followed by falling or slipping ($n = 40$, 13.3%).

Violent assault was the most common cause in male patients, traffic accidents was most common in female patients, and falling or slipping was more frequent in patients >75 years of age. Pure blow-out fractures (50.2%) were the most highly represented pattern, followed by zygomatic complex (46.5%). The most involved side in pure blowout fractures was the left side (76 patients, 25.2%).

The most common symptom was hypoesthesia extending through the territory of the TBH (32.9%). Diplopia was present in 20.2% of patients, followed by enophthalmos (2.3%) and altered ocular motility (1.7%). These findings are inconsistent with previous studies that report extraocular movement disorders (50%) and diplopia (42.3%) as the most common symptoms in orbital floor fractures (Shin et al., 2013).

In 13 patients (4.3%), the orbital fracture was accompanied by systemic injuries: 5 patients had polytrauma, 6 had cerebral trauma, and 2 had fractures of other skeletal elements. Ophthalmological examination findings included monocular vision disturbances ($n = 3$ patients, 0.9%), dystopia, lagophthalmos, deficit of the facial nerve, and subcutaneous emphysema ($n = 1$ each, 0.3%).

Clinical and radiographic analysis revealed 18 patients with concomitant facial wounds and 36 cases with associated facial fractures (31 nasal bones fractures, 3 mandible fractures, 1 sinus frontal fracture, and 1 maxilla Le Fort I type fracture).

Early surgical restoration of orbital fracture is recommended as it leads to better outcome. In this study, we performed early operation if there were clinical and radiographic signs of entrapped extraocular muscles or periorbital tissues and also in the presence of defect symptoms in the orbital structures.

Several authors recommend that operations be performed within 2 weeks of the trauma (Chi et al., 2010; Park et al., 2012; Ceylan et al., 2011). In our opinion, the indications for surgical treatment are persistent diplopia, increased orbital pressure, enophthalmos, visual weakening, extraocular movement disorders, and hypo-anaesthesia of the infraorbital nerve.

Orbital floor reconstruction was performed in all cases. The most common surgical approach was through a lower eyelid incision in 231 patients (76.7%), followed by a lower transconjunctival incision in 43 patients (14.3%). Restoration of floor integrity was most frequently performed using resorbable implants (bovine pericardium membrane; 180 patients, 59.8%). The choice of resorbable material is based on its structure: it is gradually resorbed and completely replaced by fibrous collagenous tissue, its 3-dimensional structure ensures solid support, and it is easy to shape because of its pliability (Piombino et al., 2010; Baumann et al., 2002).

Postoperative complications occurred in 115 patients (38.2% of the sample). In our study, TBH was evident in 99 patients (32.9%) before the operation and in 45 patients (39.1%) after surgical treatment. Diplopia was present in 61 patients (20.2%) preoperatively and was evident in 22 patients (19.1%) immediately after surgery. After surgery, 4 patients complained about the scar outcome (3.4%), 2 patients (1.7%) showed extraocular movement restriction, and 2 patients (1.7%) had residual enophthalmos. Of 115 patients, 73 (63.4%) had persistent complications at the 6-month postoperative follow-up: 25 (34.2%) TBH, 19 (26%) scar outcome, and 12 (16.4%) diplopia. In our study, the incidence of TBH, diplopia, and enophthalmos decreased after surgery, as was the case in previous studies (Tong et al., 2001; Hoşal and Beatty, 2002; Chi et al., 2010; Eun et al., 2007; de Silva and Rose, 2011; Ceylan et al., 2011; Novelli et al., 2011). Reoperation was performed successfully in 2 patients (0.6%).

5. Conclusions

In conclusion, we observed the following: (1) orbital floor fractures were most often seen in 15- to 24-year-old male patients; (2) pure blow-out fractures were the most highly represented pattern (50.2%), followed by zygomatic complex (46.5%); (3) violent assault was the most common cause, followed by traffic accidents and falling or slipping; (4) TBH was present in 32.9%, diplopia in 20.2%, followed by enophthalmos in 2.3% of patients; (5) the incidence of TBH, diplopia, and enophthalmos decreased after surgical repair of the orbital fracture; (6) surgery was principally performed through a lower eyelid incision and repaired with a resorbable implant; (7) no significant differences were observed between the type of material and occurrence of complications in both male and female patients; and (8) the major postoperative complications were persistent TBH (34.2%), scar outcomes (26%), and persistent diplopia (16.4%).

Conflict of interest

All authors disclose that they have no financial or personal relationships with persons or organizations that could inappropriately influence this study.

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