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Factors Influencing Outcome of Orbital Floor Reconstruction

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Abstract

Introduction Orbital floor fractures are routinely encountered in facial trauma. Many factors influence the final outcome of the orbital floor surgery, time interval and the extent of other facial bone fractures are the two factors which can significantly influence the postoperative outcome following orbital floor reconstruction. Our study aims to find the ideal time for intervention and the association of other factors in the final outcome of orbital floor reconstruction.

Methods A retrospective and prospective cohort study of patients who were operated at Pondicherry Institute of Medical Sciences for orbital floor fractures, between 2011 January and 2017 July. All the data were entered on an Excel work sheet and statistically analyzed.

Results In our study 8 patients (8/29, 27.58%) had diplopia prior to surgery, 5 patients (5/29, 17.24%) had complete recovery following surgery and 3 patients (3/29, 10.34%) had persistence of diplopia postoperatively. Patients with diplopia operated prior to 7 days were found to have significant improvement in postoperative diplopia. Patients with 5 or more facial fractures were found to have persistence of diplopia, infraorbital numbness, and enophthalmos postoperatively.

Conclusion Our study suggests that early intervention, before 7 days improves the outcome in patients with diplopia and provides a better result postoperatively. In our study preoperative diplopia and infraorbital numbness and postoperative persistence of enophthalmos, diplopia, and paresthesia were found more in patients with 5 or more facial bone fractures. Our study suggests a poor postoperative outcome when 5 or more facial bones are fractured.

Keywords
- diplopia
- orbital floor fracture
- enophthalmos
- orbital fracture score
- fracture intervention timing

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Introduction

Orbital floor fractures are often encountered in facial trauma and account for 10 to 30% of facial bone fractures.[1] Fractures of the floor of orbit and the medial wall of orbit have been found to have a protective effect on the globe, thus transmitting the destructive forces away from the orbital soft tissue and safe guarding the vision. In pure blowout orbital floor fractures, the orbital rim is well preserved. Orbital floor blowout fractures associated with fracture of the orbital rim are termed impure orbital floor fractures. The need for intervention in orbital floor fractures depends upon the clinical and radiological evaluation. Computed tomography (CT) delineates bony abnormalities in facial trauma better than other radiological modalities of investigation.[2,3] Not all orbital floor fractures warrant an intervention, orbital floor exploration is indicated when entrapment of inferior rectus is present with restriction of gaze, nonresolving diplopia, significant enophthalmos more than 2 mm, or a large orbital floor defect is present.[4] Many factors influence the outcome of the orbital floor surgery, such as age of the patient, comorbidities of the patient, the time interval between the injury and the surgery, the extent of other facial bone fractures, and the material used for reconstruction. The time interval between the injury and the surgery, and the extent of other facial bone fractures are the two factors which can significantly influence the postoperative outcome following orbital floor reconstruction.[5,6] There is no consensus on the time interval between the trauma and the repair of orbital floor to have the best postoperative outcome (►**Table 1**), though many studies suggest a time interval before 7 days as the healing process sets in during this period and adhesion between the injured structures occur.[7,8] The number of facial bone fracture associated with the orbital floor fracture gives a rough estimate of the destructive force involved in the orbital floor fracture. Higher number of surrounding facial bone fractures with orbital floor fractures are associated with a poorer outcome following orbital floor reconstruction.[9] In this study we evaluated two factors which may influence the outcome of orbital floor fracture reconstruction. These were: the timing of intervention and the number of surrounding facial bone fractures.

Table 1 Best time to intervene in orbital floor fracture

Study	Best time to intervene in orbital floor fracture
Whyte[8]	Within 14 days after the trauma
Poeschl et al[10]	More than 7 days after the trauma
Putterman et al[11]	Within 14 days after the trauma
Dal Canto and Linberg[12]	15 to 29 days after the trauma
Kasaee et al[18]	Within 4.5 days after the trauma
Our study	Within 7 days

Methods

This was a retrospective and prospective cohort study of patients who were operated at a tertiary care hospital in Puducherry for orbital floor fractures, between January 2011 and July 2018. Patient records of operated cases of orbital floor fracture repairs done from January 2011 to September 2016 were utilized to collect the data which was subsequently analyzed. Patients in the retrospective group with incomplete data were excluded from the study. Patients who had undergone surgery after September 2016 were routinely followed up at 6 weeks, 3 months, and 6 months and at the end of 6 months radiological assessment with a CT face was done. All the data were entered on an Excel work sheet and statistically analyzed using SPSS.

The parameters studied during the preoperative and postoperative evaluations were (►**Table 1**):

(1) Infraorbital numbness
(2) Enophthalmos
(3) Diplopia
(4) Gaze restriction
(5) Orbital herniation
(6) Orbital floor defect size

Each of these parameters was scored based upon a scoring system proposed by us called the Pondicherry Orbital Floor Fracture Score (POFFS) (►**Table 2**), based on a scoring system by Poeschl et al.[10] The preoperative and postoperative scores were analyzed. A minimum score of 0 to maximum score of 18 is given. Each of the parameters were assessed for the effect of time of surgery since the orbital floor fracture and associated facial bone fractures on the outcome of orbital floor reconstruction.

Inclusion Criteria

(1) Patients who were operated at a tertiary care hospital in Puducherry, for orbital floor fractures from January 2011 to July 2018.
(2) Patients willing to be part of the study.
(3) Patients with complete data in the retrospective group (January 2011 to September 2016).
(4) Patients in the retrospective group with incomplete data willing for reevaluation for completing the missing data.
(5) Patients with gaze restriction.
(6) Patients with abnormal forced duction test.
(7) Patients with significant diplopia in primary gaze or reading position even after resolution of the periorbital edema.
(8) Patients with enophthalmos greater than 2 mm on clinical evaluation after resolution of periorbital edema.
(9) Patients with orbital floor fracture size of 2 cm2 and above.
(10) Patients with progressive hyperesthesia of the infraorbital nerve.

Table 2 Scoring of factors influencing outcome of orbital floor fracture

Serial no.	Factors/Score	Findings
1.	Infraorbital numbness	
	0	No numbness
	1	Paraesthesia present
	2	Hyperesthesia/Anesthesia
2.	Enophthalmos	
	0	No enophthalmos
	1	Enophthalmos $<$ 1 mm
	2	Enophthalmos 1–1.9 mm
	3	Enophthalmos 2–2.9 mm
	4	Enophthalmos $>$ 3 mm
3.	Diplopia	
	0	No diplopia
	1	Diplopia in extreme directions
	2	Vertical or horizontal diplopia
	3	Diplopia in primary gaze
4.	Gaze restriction	
	0	Absent
	1	Present
5.	Orbital herniation	
	0	No herniation
	2	Herniation present
6.	Orbital floor defect size	
	0	No defect
	1	Defect size $<$ 1 cm^2
	2	Defect size 1–2 cm^2
	3	Defect size 2–3 cm^2
	4	Defect size 3–4 cm^2
	5	Defect size $>$ 4 cm^2
7.	Entropion/ Ectropion	
	0	Absent
	1	Present

Exclusion Criteria

(1) Patients with vision loss prior to surgery.
(2) Patients with globe rupture.
(3) Patients with fractures with orbital exenteration.
(4) Patients with orbital apex syndrome.
(5) Patients with orbital fissure syndrome.
(6) Patients who abandoned the treatment or were lost to follow-up.
(7) Patients in retrospective group with incomplete data not willing for reevaluation for completing the missing data.
(8) Patients who refused to be part of the study.

Results

Patients with orbital floor fractures were analyzed according to the time of intervention, and the number of facial bones fractured in the trauma. We divided the patients into two groups to find out the effect of time of intervention on the outcome of surgery. They were divided as those who underwent surgery before 7 days and those who underwent surgery after 7 days of trauma. We divided the surrounding facial bone fractures into two groups, fractures involving 0 to 4 facial bones, and fractures with 5 and above facial bones involved.

Fifty-six patients had undergone orbital floor fracture reconstruction during period of 2011 to 2016, and 12 patients had undergone orbital floor reconstruction from 2016 to 2018 in our center. Of these 29 patients were included in the study as others were lost on follow-up, or did not fit the inclusion criteria for the study. All patients had undergone a preoperative clinical examination, ophthalmologic examination, and CT face evaluation. Of the 29 patients who had undergone orbital floor reconstruction, it was found that there was a functional improvement in the postoperative results for patients who had undergone the surgery before 7 days.

The mean age of patients involved was 34.8 years, road traffic accident (RTA) was the most common cause of orbital floor fracture, and males were more commonly involved than females. None of the patients involved in RTA (two-wheeler accidents) had protective helmets during the incident.

The mean time interval for orbital floor exploration following facial trauma was 7 days. The mean number of surrounding facial bone fractures was 3.68. A transconjunctival approach was the most common approach used to expose the orbital floor (24/29, 82.75%). Lateral canthotomy was done in 25% (6/24) of the patients who had undergone transconjunctival approaches. All these cases had good postoperative recoveries and minimal postoperative eyelid complications.

An iliac bone graft was used in most of the cases for orbital floor reconstruction. There was no resorption of bone after 6 months of surgery on radiological evaluation, when bone graft was used for orbital floor reconstruction.

All the patients had preop enophthalmos, 7 patients (7/29, 24.13%) had no enophthalmos following surgery, and 15 patients (15/29, 51.72%) had an improvement in the enophthalmos following surgery, while 7 patients (7/29, 24.13%) showed no improvement following surgery.

Eight patients (8/29, 27.58%) had diplopia prior to surgery, 5 patients (5/29, 17.24%) had complete recovery following surgery, and 3 patients (3/29, 10.34%) had persistence of diplopia postoperatively.

Out of the 29 patients, 4 patients had no infraorbital numbness while 25 patients (86.2%) had infraorbital numbness. Out of the 25 patients, 19 patients recovered completely while 3 patients had persistence of paresthesia and 3 had developed hyperesthesia. None of the patients had anesthesia following surgery.

None of the patients had eyelid complications prior to surgery due to previous trauma or surgery to eyelid. Following orbital floor fracture reconstruction 3 patients developed eyelid complications (3/29, 10.34%). Of the three patients, two patients had entropion and one patient had ectropion. These eyelid complications developed following transconjunctival incision in two patients (one had entropion, while other patient had ectropion), and infraorbital incision in one patient (he developed entropion).

Following the surgery none of the patients had residual floor defects on reevaluation at 6 months following surgery. Patients who had undergone orbital floor reconstruction with iliac bone graft had no resorption of the bone graft. Out of the 29 patients, 1 patient had gaze restriction on preop evaluation which persisted even after orbital floor reconstruction. All the 29 patients had orbital herniation, following orbital floor reconstruction none of the patients had residual herniation.

The preop POFFS ranged from 7 to 13, preoperatively 10 patients had a score of 12 (34.5%), 7 patients had a score of 9 (24.1%), and 3 patients each had a score of 13, 11, and 10, respectively. Two patients had a score of 8 and 1 patient had a score of 7 preoperatively. The postoperative POFFS reduced from maximum preoperative score of 13 to a maximum postoperative score of 6, 9 patients had postoperative score of 3, 6 patients had postoperative score of 0, 5 patients had postoperative score of 2 and 4 each, 3 patients had postoperative score of 5, and 1 patient had postoperative score of 6.

Regression analysis was done based on the pre- and postoperative POFF scores using a master chart (►**Tables 3** and **4**), Mann–Whitney *U* test, with p-value < 0.05 was considered statistically significant. In this study patients with diplopia operated prior to 7 days were found to have significant improvement in postoperative diplopia. Patients with 5 or more facial fractures were found to have persistence of diplopia, infraorbital numbness, and enophthalmos postoperatively.

Discussion

The exact time for intervention in an orbital floor fracture remains elusive. Whyte[8] and Putterman et al[11] found the optimal time for intervention in orbital floor fracture to be within 14 days. Poeschl et al[10] recommended intervention after 7 days of trauma. While Dal Canto and Linberg[12] recommended intervention in orbital floor fracture from 15 to 29 days after trauma.

Burnstine[13] reviewed articles published from 1983 to 2002 and concluded that immediate surgery is indicated in nonresolving oculocardiac reflex, white eyed blowout fracture, and early enophthalmos. Surgery within 2 weeks is recommended for symptomatic diplopia with positive forced duction test, CT evidence of soft tissue entrapment, and CT showing large orbital floor defect. In a study done by Thaller-Antlanger,[14] it was observed that the time interval between the injury and the surgery does not influence the outcome of motility disturbance, and even late reconstruction is associated with good outcomes. Severe motility disturbances are almost always caused by isolated blowout fractures, especially with the trap-door mechanism and with fractures of the medial orbital wall. In the present study we found an association between the time interval of surgery and the postoperative improvement in gaze restriction; it was found that early intervention did improve the postoperative outcome in gaze restriction. It has been established that entrapped muscle can undergo ischemia thus causing fibrosis of the muscle and impaired movement. Hartstein and Roper-Hall[7] reviewed literature to identify the best time

Table 4 Mechanism of orbital floor fracture

Mechanism of orbital floor fracture	Frequency	Percent
Assault	5	17.2
RTA	21	72.4
Self-fall	1	3.4
Work place injury	2	6.9
Total	29	100.0

Abbreviation: RTA, road traffic accident.

Table 3 Pondicherry Orbital Floor Fracture Score (POFFS)

Parameters			Score				Maximum score
Infraorbital numbness	0	1	2				2
Enophthalmos	0	1	2	3	4		4
Diplopia	0	1	2	3			3
Gaze restriction	0	1					1
Orbital herniation	0	2					2
Orbital floor defect size	0	1	2	3	4	5	5
Eyelid complications	0	1					1
Total							18

interval for intervention and concluded that by understanding the underlying mechanism and the extent of involved fracture the need for early intervention is decided according to each patient, to give the best function and appearance.

Measuring the effect of facial trauma has been very challenging, hence leading to lack of standardized treatment and timely intervention in facial fractures. Poeschl et al[10] on retrospective analysis of patients surgically treated for isolated orbital floor fractures evaluated the functional outcome of surgery based on preoperative and postoperative clinical and radiological parameters such as type of fracture, diplopia, gaze restriction, enophthalmos, materials used for repair, surgical approach, and timing of the surgical intervention. We have devised a similar scoring system called the POFFS. The parameters studied during the preoperative and postoperative evaluations in our scoring system were infraorbital numbness, enophthalmos, diplopia, gaze restriction, orbital herniation, orbital floor defect size, and eyelid complications like entropion or ectropion. Each of these parameters was scored and the preoperative and postoperative scores were analyzed statistically.

We analyzed the patient's data as per the time of intervention and the number of surrounding facial bone fractures to observe the effects of these factors on the outcome. We divided the patients into two groups to find out the effect of time of intervention on the outcome of surgery. They were divided as patients who were operated before 7 days (0–7 days) and patients operated after 7 days of injury (►Table 5). Majority of patients with orbital floor fracture (20/29, 68.96%) presented early for surgery, while 9/29 (31.03%) presented after 7 days of injury. Patients who presented late for surgery had a higher degree of enophthalmos on presentation and persistence of enophthalmos (2 mm and above) (5/9, 55.5%) in the postoperative period, while patients who presented early for surgery had a lesser incidence of persistence of enophthalmos (10/29, 50%). We did not notice any significant difference in resolution of enophthalmos postoperatively in patients belonging to either group. However, the small number of patients in the group which presented late for surgery (more than 7 days) (9/29) makes it difficult to come to a definitive conclusion. El-Ghafar in a prospective comparative study found that early surgical intervention within 3 weeks of the injury in orbital floor fractures reduces postoperative diplopia.[15] All patients with diplopia were operated early and majority of patients had no diplopia in the postoperative period (5/8, 62.5%), the persistence of diplopia and enophthalmos even after surgical correction can be attributed to the local fibrosis and loss of periorbital fat following trauma, respectively.

Diplopia following orbital floor fracture is caused by inferior rectus contusion, local edema or mechanical restriction caused by entrapment of the extraocular soft tissue within the fracture fragments, or due to the damage to the nerves supplying the ocular muscles. Patients with preop diplopia which does not resolve with reduction in orbital edema is an indication for surgery. Diplopia which has not resolved in 2 to 3 weeks following trauma is unlikely to resolve spontaneously, without surgical intervention. Diplopia with features of muscle entrapment is a definitive indication for early surgical intervention.

The number of surrounding facial bone fractures gives an estimate of the energy transmitted to the orbit to cause the orbital floor fracture. Patients with higher number of surrounding facial bone fractures generally has poor aesthetic and functional outcome. Fractures of the thin orbital floor may arise from hydraulic forces, causing posterior globe displacement and increased orbital pressure, or from direct trauma to the inferior orbital rim, causing buckling of the floor. We divided the surrounding facial bone fractures into two groups, fractures involving 0 to 4 facial bones, and fractures with 5 and above facial bones involved (►Table 6). We have found a close relation between the fractures involving the surrounding bone and the functional outcome. The outcomes were found to be poor in patients with a greater number of facial bone fractures. Patients with higher number of facial bone fractures (5 and above) had bigger orbital floor defect (2 cm^2 and above) (92.3%), they had higher incidence of postoperative persistence of enophthalmos (2 mm and above) (76.9%), and higher incidence of postoperative paresthesia (15.3%).

The postoperative difference in enophthalmos was lesser in patients with lesser number of surrounding facial bone fractures (0–4) compared with patients with 5 or more facial bone fractures. There was a difference between the affected

Table 5 Time interval and change in preoperative and postoperative period

	Preoperative		Postoperative	
	$<$ 7 days	$>$ 7 days	$<$ 7 days	$>$ 7 days
Number of cases	20	9	20	9
Infraorbital numbness	17	7	5	1
Enophthalmos	20	9	16	6
Diplopia	6	2	3	0
Gaze restriction	1	0	1	0
Orbital floor defect	20	9	0	0
Orbital contents herniation	20	9	0	0
Eyelid complications	0	0	0	0

Table 6 Number of facial bone fractures and changes in preoperative and postoperative period

	Preoperative		Postoperative	
	< 5 fractures	5 and above fractures	< 5 fractures	5 and above fractures
Number of cases	16	13	16	13
Infraorbital numbness	13	12	4	2
Enophthalmos	16	13	11	11
Diplopia	4	4	1	2
Gaze restriction	0	1	0	1
Orbital floor defect	16	13	0	0
Orbital contents herniation	16	13	0	0
Eyelid complications	0	0	2	1

and the normal eye even after surgical repair of orbital floor, which can be explained by delayed orbital tissue atrophy following injury. Kim et al reviewed pure orbital blowout fractures and concluded that delayed orbital tissue atrophy following trauma played a major role in late enophthalmos despite orbital floor reconstruction.[16]

There was a clinical correlation between diplopia and the patients with 5 or more facial bone fractures, diplopia was commonly seen in patients with 5 or more facial bone fractures, and the improvement in postoperative diplopia was lesser in patients with 5 and more facial bone fractures

The incidence of infraorbital numbness in our study was higher in patients with 5 or more facial fractures. Postoperative persistence of infraorbital sensory complications were associated with larger defect in orbital floor (2 cm^2 and above). Jank et al in a retrospective study of orbital blowout fractures observed higher incidence of infraorbital numbness in patients with larger orbital floor defects (more than 3 cm^2).[17]

Conclusion

This study suggests that early intervention, before 7 days improves the outcome in patients with diplopia. Postoperative outcome was poor when 5 or more facial bones are fractured. Preoperative diplopia and infraorbital numbness and postoperative persistence of enophthalmos, diplopia, and paresthesia were found more in patients with 5 or more facial bone fractures.

Conflict of Interest
None declared.

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