Ophthalmological Evaluation by a Maxillofacial Surgeon and an Ophthalmologist in Assessing the Damage to the Orbital Contents in Midfacial Fractures: A Prospective Study

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Received: 6 June 2015 / Accepted: 28 August 2015 / Published online: 16 November 2015
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Abstract

Background and purpose Midfacial fractures may often be associated with injuries to the orbit which may lead to notable dysfunction of the visual apparatus, if not detected early after injury. The purpose of this study is to evaluate the associated ophthalmic injuries in mid-face trauma and to emphasize the need for understanding the ophthalmic signs and symptoms by an attending maxillofacial surgeon. **Patients and methods** A total number of 60 clinically and radiographically proven subjects with midfacial fractures were considered in the study that underwent complete ophthalmological evaluation at initial presentation. Referral to ophthalmologist was considered to determine the exact nature of injury and its implications. Results by a maxillofacial surgeon and ophthalmologist were evaluated. **Results** In our study, a male predominance with a mean age of 32 years was observed, with the most common etiology being Road Traffic Accidents. Forty-two of the 60 patients exhibited sub-conjunctival hemorrhage accounting for 70 % of ocular injuries recorded. While 28 of the 60 patients displayed peri-orbital edema (53.3 %), 8 patients experienced diplopia (13.32 %) and 8 patients showed relative afferent pupillary defect (13.32 %). **Conclusion** From our study, it becomes imperative that the maxillofacial surgeon should have a thorough knowledge of the various ophthalmic injuries that could occur in association with midfacial trauma in order to

prevent visual complications to the patient. Understanding of the subtle injuries to the ocular apparatus which may be undiagnosed by a maxillofacial surgeon but have significant grave outcomes is essential.

Keywords Midfacial fracture · Ocular injuries · Fundoscopy

Introduction

Human eye occupying only 0.3 % of the total body surface is responsible for one of the prime senses, “Vision” [1]. Natural anatomy protects the eyes from danger by providing them with hard bony enclosure (orbit) and soft cushioning (orbital fat). Despite this built-in protection, maxillofacial injuries show an associated ocular injury incidence in the range of 6–94 %, leading to significant functional and cosmetic defects.

The severity of these ocular injuries can vary from a simple subconjunctival hematoma to globe perforation or even an optic nerve lesion [2]. Both prospective and retrospective studies of patients who have sustained midfacial fractures indicate that, as many as 20 % may sustain serious ocular damage [3]. Some ophthalmic injuries may be apparent; however, other potentially blinding complications can easily be missed unless they are actively sought. Inadequate care can result in blindness, with its attendant social and medico-legal implications [4]. Examination of the orbital contents is mandatory for every patient who has sustained mid-facial trauma, severe enough to cause a fracture [5]. Hence this prospective study was set up to determine the incidence and types of ocular and motility disorders, as assessed by the maxillofacial surgeon and an ophthalmologist, in patients who had sustained midfacial

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fractures and who were under the care of a maxillofacial surgeon.

Patients and Methods

Sixty patients who reported to the emergency room at Basaveshwar teaching and General Hospital, Gulbarga, during the period from November 2011 to November 2013, who were attended by the on-duty maxillofacial surgeon from H.K.ES S.N Dental College, Gulbarga, were included in the study based on the inclusion and exclusion criteria stated below.

Inclusion Criteria

1. Age of the patients: 18–55 years
2. Patients with midfacial injury

Exclusion Criteria

1. Patients with pre-existing neurological damage or disorder.
2. Patients with pre-existing congenital or acquired ophthalmic disease or infection like optical correction by glasses or contact lenses or ocular disorders such as cataract, glaucoma, and retinal disorders, age related macular degeneration (ARMD), etc.
3. Patients suffering from long standing systemic diseases like Diabetes Mellitus (Diabetic retinopathy), Immuno suppressed conditions or systemic infection.

Methodology

After the attainment of ethical committee clearance, voluntary written consent was taken from those patients selected as per inclusion/exclusion criteria, who were then evaluated for ophthalmic injuries and baseline standardized photographs were taken. Additional radiographic investigations like CT, MRI were performed only when deemed necessary.

The ophthalmic evaluation for diagnosis of ocular injuries included the following tests: ocular motility test, visual acuity test using Snellen chart, pupillary reaction by swinging flash light test, direct light reflex, indirect light reflex, visual field testing, assessment of neuro-sensory disturbances of infraorbital nerve using two point discrimination test (Fig. 1). Patients with midface trauma having ocular injuries were further referred to Dept. of Ophthalmology to determine the exact nature of injury and its ophthalmologic implications using advanced diagnostic tools such as Retinoscopy (Fig. 2), Direct and Indirect Fundoscopy (Figs. 3, 4), slit lamp examination (Fig. 5),

Fig. 1 Two point discrimination test by using tweezer for checking neurosensory deficit

Fig. 2 Retinoscopy

Fig. 3 Direct funduscopy testing for fundus evaluation

fluorescent staining (Fig. 6), Schiotz tonometer (Fig. 7), and Hertel exophthalmometer. The findings of the maxillofacial surgeon and the ophthalmologist were evaluated.

Results

It is observed in our study that there is a male predominance with 51 (85 %) patients being males, 9 being female patients (15 %) in the total of 60 patients selected, showing

Fig. 4 Indirect funduscopy

Fig. 5 Slit lamp examination

Fig. 6 Fluorescent staining to know corneal epithelial defect

a mean age of 32 years. The etiology of midfacial injuries in 55 patients was road traffic accidents, accounting for 91.6 % while assault was the cause in 3 patients, accounting for 5 % followed by self fall in 2 patients (3.33 %).

The various types of midfacial fractures with ocular injury encountered in the study and the distribution of

Fig. 7 Recording intraocular pressure with Schiotz tonometer

study parameters in them were recorded. The various midface fractures (Table 1) documented were: (1) Malar fracture-undisplaced (15 %), (2) Zygomatic arch fracture only (11.67 %), (3) Tripod fracture with undistracted FZ suture (13.33 %), (4) Tripod fracture with distracted FZ suture (3.33 %), (5) Pure blow out fracture of the orbit (5 %), (6) Fracture of the orbital rim only (6.67 %), (7) Le Fort I fracture only (6.67 %), (8) Le Fort II fracture only (6.67 %), (9) Le Fort III fracture only (1.67 %), (10) Nasal bone fracture (NOE) (18.33 %), (11) Combination of above fractures (13.33 %).

Most common ocular injury in our study (Table 2) was sub conjunctival hemorrhage 42 (70 %), periorbital edema 28 (53.3 %), followed by diplopia 8 (13.32 %), RAPD 8 (13.32 %), ptosis, infraorbital nerve paresthesia, enophthalmos, traumatic hyphema each of three cases (5 %).

Correlation of different ocular injuries with these fractures revealed that the incidence of enophthalmos and diplopia occurring in orbital blow out fractures was found to be highly statistically significant with p value 0.001. Increased intraocular pressure occurring in Lefort III fractures was also found to be statistically significant with p value 0.001 in the study.

In 14 of 60 cases, ophthalmic injuries were undiagnosed by a maxillofacial surgeon at the initial presentation and later diagnosed with the help of an ophthalmologist who actively intervened in 9 of these cases to prevent visual disturbances to the patients, highlighting the importance of identification of such inconspicuous ocular injuries.

Discussion

Midfacial trauma is usually associated with ocular injuries, which comprise of a vast majority of presentations, ranging from a simple subconjunctival hemorrhage to the most severe complication of blindness [6]. Rapid assessment and examination following trauma to the eye is crucial. A thorough knowledge of potential injuries is imperative to ensure rapid diagnosis, to prevent further damage to the eye, and to preserve visual capacity [7]. Although the eye

Table 1 Type of midface fracture

Sl. no	Type	Number	Percentage
1	Malar fracture-undisplaced fracture any site	9	15.00
2	Zygomatic arch fracture only	7	11.67
3	Tripod fracture with undistracted FZ suture	8	13.33
4	Tripod fracture with distracted FZ suture	2	3.33
5	Pure blow out fracture of the orbit	3	5.00
6	Fracture of the orbital rim only	4	6.67
7	Le Fort I fracture only	4	6.67
8	Le Fort II fracture only	3	5.00
9	Le Fort III fracture only	1	1.67
10	Nasal bone fracture (NOE)	11	18.33
11	Combination of above fractures	8	13.33

represents only 0.3 % of the total surface area on the human body, loss of vision in one or both eyes has been classified as a 24 or 85 % whole-person impairment or disability, respectively [1]. The literature displays a consensus that an accurate ocular assessment must precede the surgical treatment of midfacial ocular fractures [8].

In the present study, the patients who presented with midfacial injuries were predominantly male, which can be explained by more number of males driving the motor vehicle inferring the most common etiology as road traffic accident. This was similar with the findings of Al-Qurainy et al., Brown et al., Fabio Roccia et al. and Mackinnon et al. [6, 8–10]. The second leading cause in our study was assault as suggested by Al-Qurainy, Barry et al., and Jamal et al.

Subconjunctival haemorrhage is frequently encountered in ocular trauma and is traditionally left untreated awaiting spontaneous resolution unless associated with open globe

injury [11]. The incidence of subconjunctival hemorrhage (Fig. 8) in this study was 70 %, the most common presenting sign in ocular injury, which correlates with the study done by Mimura et al. [12], where incidence of subconjunctival hemorrhage in trauma was 77 %, most common location being temporal region followed by the nasal region [13]. Trauma was noted as the commonest etiology for subconjunctival hemorrhage by Kaimbo et al. [14]. We observed chemosis (Fig. 8) in four cases in our study, two cases of chemosis were observed in blow out fracture, one case each in tripod fracture and combination of Le Fort II and nasal bone fracture.

Periorbital edema and circumorbital ecchymosis (Fig. 8) are the most prominent initial features in patients presenting to the hospital following trauma to the orbit. The appearance of the ecchymosis and edema can be dramatic and make examination of the orbit challenging. In this

Table 2 Types of ocular injuries **Fig. 8** Bilateral upper lid tear with circumorbital ecchymosis having sub-conjunctival haemorrhage on right eye and chemosis on left eye

study we could find around 53.3 % cases of periorbital odema and 50 % cases of circumorbital ecchymosis which was consistent with the findings of Sharon et al. [7].

Eight diplopia cases were seen with male predominance. Three cases of diplopia seen in our study were caused by orbital blow out fracture with inferior rectus muscle involvement and two cases of diplopia were due to displaced tripod fracture with distracted FZ suture and two other cases of diplopia were due to combination of fractures i.e. Le Fort II with nasal bone fracture, due to the involvement of lateral rectus and inferior rectus muscle. We had one case of diplopia due to the involvement of bilateral 6th CN (Fig. 9) in case of tripod fracture which is probably due to the raised intracranial pressure. In this particular case the diagnosis was done by performing the forced duction test. The reported incidence of diplopia following midfacial fractures ranges from 1 to 32.1 % [15], whereas the incidence of diplopia in our study is 13.33 % which is similar to the study conducted by Hakelius and Ponten [16] and Steidler et al. [17]. Al Qurainy et al. [17],

Fig. 9 Diplopia due to involvement of bilateral 6th CN nerve

reported 58 % of diplopia in their study which were caused by orbital blow out fracture and Barry et al. [18], who reported that diplopia is associated with 36 % of orbital blow out fractures. The higher incidence rate can be attributed to the fact that the study subjects were all cases of orbital fractures [19].

The Hess chart screening is a valuable tool as it gives accurate information regarding the effective action of the corresponding or synergic muscles of the two eyes and shows how the movement of one eye is in excess of, or less than that of the other eye [20].

Retrobulbar hemorrhage is hemorrhage into the potential space surrounding the globe which may occur following blunt trauma because of injury to the orbital vessels, leading to acute visual loss [7]. The present study shows a case (1.67 %) of retrobulbar haemorrhage in association with Le Fort III fracture which was diagnosed by an ophthalmologist during fundoscopy. Our results are comparable with study done by Mittal et al. [4].

Traumatic hyphema is detected by slit-lamp examination by an ophthalmologist. The most common complication of hyphema is rebleeding, which occurs 2–5 days following injury when the initial clot retracts and loosens [7, 21]. In our present study we had three cases of traumatic hyphema (5 %) in blunt trauma, one case of pure blow out fracture and two cases were associated with tripod fracture. This result is comparable to the study conducted by Gaurau Mittal et al. [4].

In our study, raised intraocular pressure was documented in one Lefort III fracture case, six cases of tripod fracture and one case of blow out fracture which was statistically significant ($p < 0.05$). The values were between 21 and 22 mm Hg [22]. The incidence of raised intraocular pressure was 5.9 % in this study.

In maxillofacial trauma, zygomatic complex fractures are the second most common fractures of facial skeleton accounting to about 15 % of all facial fractures [6, 23]. Midfacial trauma usually involves the infra-orbital rim

which continues along the infra-orbital foramen leading to sensory neuropathy along the distribution of infraorbital nerve [24]. This neurosensory deficit was evaluated by two-point discrimination test. The incidence of infraorbital nerve paresthesia varies from 35 to 94 % of all the zygomatic complex fractures [25]. In our study, three patients (5 %) had neurosensory deficit, the value being low as compared to the studies of Ahmed et al. (91.73 %) [26]. However our findings showed similar incidence as compared to the studies of Zingg et al. (7.4 %) [27], and Larsen et al. (7 %) [28]. We observed infraorbital nerve paresthesia in three patients, all of whom had sustained tripod fractures.

The incidence of enophthalmos in our study was 5 %. Jayamanne et al. reported a high frequency of enophthalmos occurring in orbital blowout fractures, which is consistent with our study as all the cases of enophthalmos occurred in orbital blowout fractures, with the value being 01 mm [29, 30]. This was statistically significant ($p < 0.05$). Folkstead and Granstrom reported an incidence of 19 %, the higher incidence rate may be explained by the fact that the study subjects were all cases of orbital fractures [19].

Traumatic corneal abrasion is a common presenting problem encountered in emergency departments. Minor (small) corneal abrasion is expected to heal in 1–4 days [31]. Extensive or deep abrasions require a week to heal. This was diagnosed by an ophthalmologist using slit lamp, by staining the cornea with fluorescent stain. The incidence of corneal abrasion in this study was 1.67 %. There were no studies found relating to midfacial trauma and corneal abrasion.

Vitreous hemorrhage occurs when blood enters the normally avascular vitreous space, which is filled with a clear gelatinous material. This is an emergency situation requiring ophthalmologist consultation as 11–44 % of vitreous hemorrhages are associated with retinal tears [7]. We encountered two cases (3.33 %) of vitreous hemorrhage in our study.

Comotio retinae (Berlin's edema) which is the contusion injury of retina is most commonly seen in the posterior pole, but it can occur anywhere in the retina [6]. We can expect a direct relationship between blowout fracture and commotio retinae, but only one patient (1.67 %) presented with this complication. Studies have demonstrated this injury to be present in 9–14 % of blowout fractures [6, 7].

In our present study we had one case of retinal detachment (1.67 %), one case of traumatic cataract (1.67 %) and three cases of traumatic optic neuropathy (5 %) in tripod and Le fort III cases, which were diagnosed by an ophthalmologist by using slit lamp and fundoscopy. Although the ophthalmologist may assist in making the diagnosis of

Fig. 10 Traumatic optic neuropathy

traumatic optic neuropathy (Fig. 10), there is little evidence that any intervention by the ophthalmologist will change the visual outcomes in case of optic nerve avulsion [32].

The following ophthalmic injuries would have gone unnoticed had we not referred the patients for ophthalmological evaluation:

- 1 case of retro bulbar hemorrhage
- 1 case of corneal abrasion
- 3 cases of traumatic optic neuropathy
- 3 cases of traumatic hyphema
- 1 case of traumatic cataract
- 1 case of retinal detachment
- 1 case of Berlin's oedema
- 1 case of vitreous hemorrhage
- 1 case of lens subluxation.

This suggests that ophthalmologists are able to detect ocular injury that is not apparent to the non ophthalmologist.

Conclusion

Our study reaffirms the tenet that the assessment of visual acuity should be performed in all patients sustaining mid-facial fractures. It is evident from the study that the ocular injuries, though might not affect the surgical treatment plan of midfacial fractures, definitely influences the timing of surgery, as certain ocular injuries need immediate ophthalmic intervention to avoid potential blinding complications. It is essential that the maxillofacial surgeon have a thorough knowledge of the various ophthalmic injuries that could occur in association with midfacial trauma in order to prevent visual complications to the patient. Understanding of the subtle injuries to the ocular apparatus which may be undiagnosed by a maxillofacial surgeon but have significant grave outcomes, is necessary. To obtain a more conclusive and comprehensive evaluation an interdisciplinary approach

is required. Hence the maxillofacial surgeons must be trained to perform a basic fundoscopic examination so as to rule out any posterior segment pathology, which can be easily learnt with the inter-departmental cooperation.

Compliance with Ethical Standards

All procedures performed in our study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest Dr. Satishkumar Patil, Dr. Imtiaz A Kotwal, Dr. Udupikrishna Joshi, Dr. Soumya Allurkar, Dr. Nitin Thakur and Dr. Aafreen Aftab declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

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