Management of panfacial fractures, multicentric retrospective study

Original Article

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ABSTRACT

Introduction: Pan facial fractures are defined as those involving the upper, middle, and lower thirds of face simultaneously. However clinically speaking, the term can be used if only two-third of the face were involved. There is great controversy in the literature regarding sequence of repair of pan facial fractures, from inside to outside versus outside to inside, or top to buttom versus buttom to top. We introduced our experience for management of these cases.

Patients and Methods: Retrospective multicentric study conducted at maxillofacial surgery unit, general surgery department, Sohag University, Sohag, Egypt and King Fahd specialist hospital, Qassim province, Saudia Arabia. The study included all cases with panfacial fractures who presented and surgically treated between January 2017 and December 2021.

Results: Panfacial fractures involved the middle and lower thirds were the most common pattern (39.9%) followed by those involving the Upper, middle, and lower thirds (32.3%) and those affecting Upper and middle thirds (20.4%). The least pattern was Upper and lower thirds involvement (7.4%).

Conclusion: We customized the method for each patient in our study because there were a variety of fracture patterns. Actually, we fixed the static bones first, then the mobile ones. To ensure correct reduction and prevent compounding error by fixing following more comminuted fractured segments, it is advisable to start with less comminuted segments that have more visible reference points.

Key Words: Dental arches, facial deformities, facial skeleton, malocclusion, pan facial fractures.

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INTRODUCTION

Pan facial fractures are simply defined as those involving the upper, middle, and lower thirds of face simultaneously. These complex fractures involve the frontal bones, zygomaticomaxillary complex, nasoethmoid region, maxilla and mandible[1]. However practically speaking the term can be used if only two areas were involved[2].

The most common cause of panfacial fractures is high-energy trauma (e.g., motor vehicle or gunshot injuries). Between 4% and 10% of all facial fractures are panfacial fractures[3]. Usually, these serious injuries are linked to other injuries that require immediate attention; for instance, 20% of these patients also have concurrent cervical spine injuries[4].

Soft tissue damage and the breakdown of the skeletal structure are frequently associated with pan facial fractures, leading to malocclusion or facial deformities such as the ‘dish‘ face deformity, loss of facial height or projection, increased facial width, and enophthalmos[5].

The most used method for diagnosing facial trauma is computed tomography (CT) imaging. The current standard for examining the entire face skeleton, however, is thin cut (1 mm or less) CT images, When there are insufficient reference points for panfacial trauma patients, three-dimensional (3D) reconstruction of CT images can help even more with preoperative planning[6].

For maxillofacial surgeons with and without expertise, managing panfacial trauma poses a challenge in terms of both achieving the desired facial aesthetics, contours and functional outcomes. Inadequate outcomes are produced by incorrect diagnosis, treatment planning, and sequencing. However, results can be maximized with access to precise imaging, stiff fixation, bone grafting methods, and appropriate sequencing[7].

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Since there is less of a normal framework to guide anatomic reduction, treating panface fractures is more challenging than treating isolated facial fractures. Due to the large number of fracture sites, it is essential to assess existing and potential deficiencies as well as the optimal plan of action for surgery and subsequent care[6]. In addition, these patients frequently arrive with other severe traumas that need to be treated simultaneously. Maintaining airway patency, fostering the best possible deglutition and speech, and restoring the preinjury face aesthetics in terms of height, breadth, and projection are all benefits of properly reducing facial fractures[6].

Treatment for panfacial fractures is complicated, and each patient needs a customized strategy. A lot of literature has been produced about the ideal order in which to treat panfacial fractures[2,8–11]. There is no universal consensus on the optimal sequence for fracture healing among the several sequences (top to bottom, bottom to top, medial to lateral, and lateral to medial) that have been documented in the literature[7].

Neither one of these techniques will achieve optimal results in every situation. Instead, an approach that goes from known to unknown, immobile to mobile, and simple to complicated is certainly more accurate. For example, if there is a significant calvarial injury, it may be difficult to start from the cranium and proceed caudally. In this case, a sequence that starts caudally and proceeds cranially may achieve more optimal results, allowing the surgeon to reconstruct the damaged cranial portion last. Conversely, if there is significant comminution of the mandible or if key segments are missing, it may be more appropriate to start cranially and proceed caudally[7].

Reconstruction should be handled as solving a jigsaw when there are many facial fractures including the top, middle, and lower face. Damaged sections can be more precisely rebuilt by utilizing known landmarks and anatomy. Key markers such as the mandible, maxillary buttress, sphenozygomatic suture, dental arches, and intercanthal area may aid in determining the correct alignment of the facial skeleton[7].

Aim

In this article, we used a simple rationale for the management of panfacial fractures. The aim of this work was to introduce a simple approach for the management of panfacial fractures and evaluate the outcome of our approach in such cases.

PATIENTS AND METHODS:

Study design, setting and population

Retrospective multicentric study conducted at maxillofacial surgery unit, general surgery department, Sohag university, Sohag, Egypt. And king fahd specialist hospital, qassim province, Saudia Arabia. The study included all cases with panfacial fractures who presented and surgically treated between January 2017 and December 2021.

Inclusion criteria

Adult cases aging 18 years and more.

Exclusion criteria

Patients aging less than 18 years, patients who were unfit for surgery, cases that present after three weeks of initial trauma, and cases which were subjected to previous surgery for treatment of their panfacial fractures.

Ethical approval

The study was conducted according to principles of Helsinki and approved by the institutional review board and ethics committee of Sohag faculty of medicine.

Our approach

Case evaluation

Most of the cases present to the Emergency department as polytraumatized patients. The Advanced Trauma Life Support guidelines were followed. A thorough examination of the patient is necessary and other life-threatening conditions were managed first. All patients had detailed history, clinical examination and routine investigations. (Figure 1), Maxillofacial CT scan with 3D reformatting were performed when the general condition was stabilized.

Fig. 1: Intubated patient with panfacial fracture at emergency unit.

(a) Timing of surgery: Although most patients were going to get life-supporting care beforehand owing to injuries to their organs or central nervous systems, surgery was done as quickly as feasible. That’s why the procedure took 2 or 3 weeks.

(b) The aim of surgery: In order to offer function and aesthetics, it was necessary to restore the premorbid occlusion, the major facial buttresses before taking into account the minor buttresses, and the premorbid facial breadth and height.

(c) Anesthesia: surgery was performed under general anesthesia either through tracheotomy or submandibular intubation technique.

(d) Incisions: Multiple incision types were used to achieve complete exposure of the fracture sites: coronal, lateral eyebrow, lower eyelid, subciliary, mandibular and maxillary gingival-buccal-sulcus, preauricular-retromandibular, and translaceration incisions.

(e) Sequencing the repair is variable according to each case. We started with most known, simple, immobile and stable fractures, and least comminuted fractures and using the less-affected side as a guide and ending with osteosynthesis of the tooth-bearing segments.

(f) Establishing premorbid occlusion

After several fractures along main facial buttresses were exposed, mobilized, and reduced, premorbid occlusion was re-established utilizing maxillomandibular fixation. In order to preserve appropriate facial breadth, palatal fractures that are present should be disimpacted and fixed so that the mandibular dental arch can be modeled after the maxillary dental arch.

Lower face (Mandibular) fractures

In order to lessen and stabilize the fractures, transoral, extraoral, and translaceration techniques were applied. A helpful guide along the parasymphysis and body might be the inferior edge of the mandible. (Figure 2), an external technique can be used to visualize the inferior and posterior margins along the angle. To restore the correct mandible height, open reduction and internal fixation of at least one side of bilaterally displaced condylar fractures were carried out prior to reducing the other mandibular fractures.

Fig. 2: Fractured mandible treated by open reduction and internal fixation.

Midface fractures

Along the lateral vertical buttress, the zygomaticomaxillary complex (ZMC) fracture site was conveniently identified by the maxilla's lateral curvature. A ZMC fracture frequently involves the zygomaticofrontal suture line, which can be found as a marker along the lateral orbital rim. The pyriform aperture curvature is a valuable marker along the medial vertical buttress, fully exposed from the nasal floor to the nasal bone (Fig. 3).

A continuous and decreased infraorbital rim might demonstrate proper reduction of the lateral and medial buttresses. Repairing the orbital floor may be possible when the medial and lateral vertical buttress fractures are fixed.

Fig. 3: Midface fracture treated by open reduction and internal fixation.

Naso-orbito-ethmoid fracture (NOE)

Medial canthopexy is used for naso-orbit-ethmoid (NOE) fractures if the medial canthus is damaged. Our favorite method for repositioning the medial canthus was to utilize 3–0 Prolene to a hole that could be accessed using a mini plate, a bone tunnel, or a tiny screw. A similar method can be used to repair lateral canthus separation. Limited septoplasty or nasal fracture reduction was done if there was a nasal or septal bone fracture that needed to be fixed. It is necessary to undergo lacrimal duct stenting if there is a lacrimal duct damage. However, lacrimal stenting was postponed with a plan for a phased dacryocystorhinostomy until the tissue quality had improved if there was a major disruption to the medial canthus.

Upper face fractures

In the case of a fractured anterior table of the frontal sinus, the superior orbital rim was exposed to restore the normal shape of the frontal bone in the top face. An anteriorly based pericranial flap should be raised if frontal sinus obliteration or cranialization is the proposed procedure. Repairing a face fracture should come first if frontal sinus obliteration, cranialization, or anterior skull base restoration is necessary. (Figure 4), before scalp closure, the cranial vault fracture was corrected after the frontal sinus and superior orbital rim fractures were minimized and stabilized.

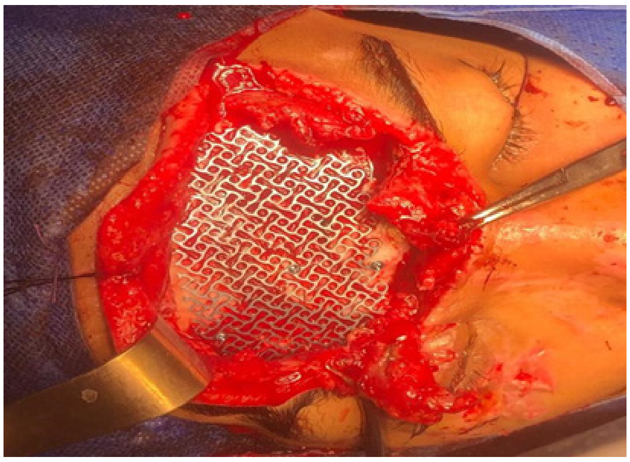

Fig. 4: Comminuted frontal bone fracture reconstructed using titanium mesh.

Soft tissue injuries management

Finally, if there was associated soft tissue injury proper management was performed.

Postoperative care

All cases were admitted to ICU where they received postoperative care and medications until they were stable then they were transported to the inpatient department. The stitches were removed 5 days after surgery while removal of intraoral stitches was done after 2 weeks with follow up radiography. The intermaxillary fixation was removed and the occlusion was checked. If there was no specific reason, the arch bars were after 4-6 weeks. If there was malocclusion, intermaxillary fixation with elastic rubber bands was done and the patient did mouth opening exercises once daily until removal of the arch bars 8 weeks after surgery.

Follow-up

The patients were discharged from the hospital with instructions to come for regular follow up visits monthly for 1 year then every 3 months next year to assess the outcome, and detect the complications.

Outcomes

Were assessed at 6 months and 12 months after surgery.

Functional outcome

Mouth opening (good: 3 finger breadth or more, accepted: 2–3 finger breadth, bad: less than 2 finger breadth).

Dental occlusion (good, accepted: mild malocclusion, bad: severe malocclusion).

Eye position (normal, enophthalmos, proptosis, orbital dystopia, hypertelorism, squint).

Vision: (normal, diplopia, decreased visual acuity).

Aesthetic outcome

Central face unit: assessment of NOE reconstruction.

Lateral face units: assessment of facial height restoration.

Facial symmetry: assessment of Facial height and Facial width.

RESULTS:

The study included 421 patients. They were 373 (88.1%) males and 48 (11.9%) females. Their ages ranged between 18 and 68 years. The most affected age group was the third decade (30.4%) followed by the fourth decade (27.6%) while the least involved was the seventh decade (3.6%) (Table 1).

The most common mechanism of trauma was road traffic accidents (66.3%) followed by work injuries (13.5%) and assaults (11.4%) (Table 2).

Panfacial fracture involved the middle and lower thirds were the most common pattern (39.9%) followed by those involving the Upper, middle, and lower thirds (32.3%) and those affecting Upper and middle thirds (20.4%). The least pattern was Upper and lower thirds involvement (7.4%) (Table 3).

The most common concomitant injuries were encephalic (58.2), followed by orthopedic injuries (31.4), then abdominal injuries (25.2), and the least common was the associated ocular injuries[9].

According to our results, most of our patients had satisfying outcomes, and 366 (87%) patients had perfect occlusion. Despite high-energy trauma, Only six (1.5%) patients had osteomyelitis, 403 (95.7) patients had normal globe position. 22 (5%) patients had diplopia.388 (92%) patients were happy with their scars, although remaining 33 (8%) patients offered scar revisions by plastic surgery. 410 (97.3%) patients had patent upper airways, however, 11 (2.7%) patients had nasal obstruction, all managed by combined treatment with the ENT team. In general, most of our cases were satisfied with their final results.

Table 1: Age and sex

Age group	Males (N=373) [n (%)]	Females (N=48) [n (%)]	Total (N=421) [n (%)]
18–20	21 (5)	3 (0.7)	24 (5.7)
20–30	112 (26.6)	16 (3.8)	128 (30.4)
30–40	101 (24)	15 (3.6)	116 (27.6)
40–50	70 (16.6)	10 (2.4)	80 (19)
50–60	55 (13.1)	3 (0.7)	58 (13.8)
60–70	14 (3.3)	1 (0.2)	15 (3.6)
Total	373 (88.1)	48 (11.9)	421 (100)

Table 2: Mechanism of trauma

Mechanism of trauma	Frequency (*N*=421) [*n* (%)]
Road traffic accidents (RTA)	279 (66.3)
Work injuries	57 (13.5)
Assaults	48 (11.4)
Sport	15 (3.6)
Falls	13 (3.1)
Firearm and gunshots	9 (2.1)
Total	421 ()

Table 3: Fracture pattern

Involved parts of the face	Frequency (*N*=421) [*n* (%)]
Middle and lower thirds	168 (39.9)
Upper, middle, and lower thirds	136 (32.3)
Upper and middle thirds	86 (20.4)
Upper and lower thirds	31 (7.4)
Total	421 (100)

Table 4: Concomitant injuries

Concomitant injuries	Frequency (*N*=751) [*n* (%)]
Encephalic	245 (58.2)
Orthopedic	132 (31.4)
Abdominal	106 (25.2%)
Thoracic	94 (22)
Spine	64 (15)
Ocular	41 (9)
Total	751

Table 5: Fracture site

Fracture site	Fracture pattern	Right	Left	Bilateral	Total
Upper third (253 patients)	Frontal sinus, anterior wall	33	36	47	116
	Frontal sinus, posterior wall	11	16	9	36
	Frontal sinus, anterior and posterior walls	23	31	47	101
Middle third (384 patients)	Orbital floor	14	12	8	32
	Orbital medial wall	13	11	26	50
	Orbital roof	23	27	31	81
	Orbital lateral wall	15	16	41	72

	Le Fort I	18	16	44	78
	Le Fort II	17	19	51	89
	Le Fort III	21	26	41	88
	Nose	11	9	56	76
	Palatal bone	16	21	33	70
	NOE		149		
	Dentoalveolar	33	39	48	120
Lower third (335 patients)	Condyle	21	23	155	199
	Coronoid	7	9	5	21
	Ascending ramus	19	17	21	57
	Angle	33	36	26	95
	Body	18	19	23	60
	Parasymphysis	35	33	9	77
	Symphysis	–	–	23	23
	Dentoalveolar	16	19	27	62

Table 6: Complications

Complications		
Functional complications	Nasal obstruction	11
	Trismus	36
	Anterior open bite	17
	Diplopia	22
	Malocclusion	38
	Para-esthesia	19
Aesthetic complications	Enophthalmos	18
	Facial asymmetry	29
	Telecanthus	9
	Traumatic hypertelorism	7
	Ectropion	9
	Ugly scar	33
Others	Osteomyelitis and sequestrum	6
	Plate exposure	41

DISCUSSION

A tertiary health care facility should handle panfacial fractures since they need a high level of skill[8]. Due to the extreme degree of comminution, other serious concomitant systemic injuries, (Table 4), the loss of all reference segments that may direct the process of facial reconstruction, (Fig. 1), even skilled surgeons find it challenging to restore the original face architecture[9–12].

The order of panfacial fracture healing is a topic of ongoing debate. In actual practice, a surgeon should be flexible and employ a combination of sequences because every fracture situation is unique. Wang *et al*. used a variety of techniques, such as 'top down' or 'bottom up,' 'inside-out,' and 'outside-in,' to treat panfacial fractures. The 'top-down' method begins the reduction at the upper face and calvarium, (Fig. 4), moves down the midface, and terminates at the mandible. Restoring the premorbid occlusion and fixing the mandibular fractures are the first steps in the 'bottom-up' technique. Next come the midfacial fractures, and finally the superior orbital rim, frontal sinus, and cranial vault. 'Outside-in' refers to starting from the outside and working your way inward. For instance, you may start at the ZMC fractures on the lateral buttress and work your way along the medial buttress toward the NOE section. 'Inside out' suggests the contrary[6].

Since there is not a precise categorization for panfacial fractures, several reduction procedures are used to restore facial shape[13]. These reduction sequence combinations have been compared in several research. Nevertheless, the effectiveness of top-to-bottom or bottom-to-top sequences has not been evaluated in isolation from inside-out or outside-in sequences[3,10,12,14]. The most popular technique for treating panfacial fractures is the 'bottom to-top and outside-in' strategy[3,8,10,12,14].

We customized the method for each patient in our study because there were a variety of fracture forms and sites. (Table 5), actually, we fixed the static bones first, then the mobile ones. The combination procedure is the best way to proceed. To guarantee appropriate reduction and prevent compounding mistakes by fixing of succeeding more comminuted fractured segments, we combined both methods and started with less comminuted segments with more visible reference points.

The frontozygomatic suture and zygomatic arch are reduced and fixed to reconstruct the central midface once the frontoglabellar area has been sufficiently rebuilt. This allows for the midface to be adequately wide and anteriorly projected. Rebuilding of the NOE facility is then completed. After that, the lower midface is rebuilt by reducing and fixing the vertical buttresses of the external and internal frames, with the zygomaticomaxillary buttress and pyriform rim serving as guides. (Figure 3), Reconstruction of the orbital floor, nasal dorsum, and, if needed, the medial canthopexy, is the last phase. A common reason for surgical failure is incorrect reconstruction of the NOE area, which is critical for face esthetics.

To create the outer facial frame and offer upper facial breadth and projection before NOE, maxillary, and mandibular reconstruction, Gruss and Phillips[15] recommended beginning panfacial reconstructions with a decrease of the zygomatic arch and malar projection. The NOE region presents a challenge in determining a secure fixation location due to the fragility of NOE fracture fragments.

Few writers have advocated for the outside-in sequence over the inside-out sequence. Merville[16] recommends treating the NOE fracture first in cases of panfacial fractures including it. He does, however, also stress the significance of the external facial framework and the need for fronto-maxillary and zygomatic frame treatment for the NOE fracture.

Pau *et al*.[17] recommend flipping the outside-in strategy of treatment for bilateral condylar fractures. For several reasons, they advise beginning with the mandibular symphysis. (Figure 2), first, because there is little exposure, internal fixation and reduction in the condylar region are difficult. Because there is little exposure and little bone in the condyle neck region, only one four-hole plate is often employed to attach the condyle neck. During symphysis correction, a single fixation of condyle fractures may become unstable. Second, symphysis could be fixed more steadily than condyle, and condyle could be steadily adjusted after symphysis with two-point hard fixation of symphysis.

Because condylar height and malar projection are the most crucial factors in determining face shape, surgeons typically feel that the outside-in sequence is the most dependable method for correcting panfacial bone in the absence of bilateral condylar fractures. The frame, which is determined by projection and height, should be followed for medial fractures such as NOE, symphysis, and parasymphysis fractures[13].

Some surgeons feel that there is a significant advantage to the top-down and outside-in approach because it might not be essential to treat the condyles openly. In the event of comminuted intracapsular fractures, the patient is treated with varied durations of maxillomandibular fixation, which might be a reasonable strategy. There are two possible issues with this, even if it is a feasible choice in some circumstances. One is a widening caused by an unnoticed rotation of the mandibular ramus or body. The failure to start physical treatment early results in temporomandibular joint ankylosis, which is the second consequence. In their assessment of closed therapy for mandibular condyle fractures, Hiawitchka *et al*. revealed poor outcomes[18]. Patients with condylar head fractures are typically advised to open their mouths early and use guiding elastics to preserve their temporomandibular joint's range of motion[7].

A total of 53 cases were evaluated by Kim and colleagues. The majority of these fractures were amenable to an outside-in methodology. They chose the outside-in sequence over the inside-out sequence because they believed that the malar projection had the most significant role in the decrease of the panfacial bone. In contrast to the majority of instances, they favored the inside-out method in unique situations involving frontal bone fractures close to the nasofrontal junction. When there was no discernible comminution of the nasoethmoid area but open wounds close to the frontal bone fracture site, the zygomaticomaxillary segments were reduced by rigidly fixing the fracture segments to the frontal bone, which served as a trustworthy landmark. They thought that the frontal bone would be sufficient to sustain the reduction of the supraorbital rim and nasomaxillary buttresses[13].

The top-to-bottom and outside-in sequences (six patients) and the bottom-to-top and inside-out sequences (five patients) have been compared by Degala *et al*.[10]. Good occlusion was achieved by the patients in both groups, and there were no statistically significant variations in mouth opening between the groups. Two patients in each group had facial asymmetry, but there was no discernible difference in the way therapy turned out in the end. The surgeon's preference and the fracture pattern determine which sequence to adopt, as both produce comparable clinical results (Table 3).

According to Yun *et al*., face measurements such as width, height, and projection must be taken into account, with facial width being the most crucial factor. Because variations in width are far simpler to identify when comparing projection and height. Variations in height and projection are uncommon and difficult to identify. When utilizing the 'inside to outside' reduction procedure, it might be simple to overlook the gap resulting from bone loss, and inadequate reduction may lead to asymmetry in face breadth. Conversely, the 'outside to inside' method makes it simple to establish face symmetry by arranging the zygomatic arch and body first. It might create sufficient room for a collapsed or badly fragmented NOE fracture, making it simple to determine whether to utilize a bone transplant by measuring the gap left by bone loss. For this reason, the author prefers the 'outside to inside' method, and in the majority of his cases, the outcomes are satisfactory[19].

Custom-made patient implants combined with virtual surgery planning are quickly becoming increasingly widely used since they provide more accuracy to achieve the best functional and aesthetic outcomes[6]. According to a literature analysis by Mundinger *et al*. routine administration of postoperative antibiotics is not suggested unless there is an infection before surgery repair[20]. However, in situations of really unclean wounds, it is prudent to think about using antibiotics, particularly if the injury impacted important neurovascular systems near the base of the head or in the neck. For 6–8 weeks following surgery, mastication should be restricted to a soft diet to prevent applying force on the recovering maxillomandibular unit. Exercises for opening the jaw should be a part of long-term therapy, particularly if the condyles are hurt, in order to prevent temporomandibular joint ankylosis (TMJ).

Prolonged rigid maxillomandibular fixation should be avoided wherever feasible, given related problems such as low patient satisfaction, trouble with feeding, and risk of deadly aspiration after vomiting, especially if mandible and maxilla fractures were treated via open method[6].

In our study 88.1% were males, 11.9% were females. The third decade of life was the most commonly affected age group (Table 1). Also road traffic accident was the most common cause of panfacial fractures followed by work injuries and assaults (Table 2). 87% of patients had recovered their normal occlusion. Majority of our patients were satisfied with their final outcomes.

Mild malocclusion can be treated without surgery with orthodontics or elastics. Orthognathic surgery is necessary in situations that are severe or unresponsive. Le Fort I osteotomy was necessary for every patient in He *et al*.'s series to treat malocclusion. With the exception of two patients, this group's outcomes were favorable, with all of them recovering to proper occlusion. These two patients had severe trismus, which prevented them from having preoperative dental imprints taken. Five patients in this research (Table 6), required corrective orthognathic surgery, three patients required correctional orthodontic treatment, two patients declined surgery and accepted their malocclusion, and 33 (8%) patients had moderate malocclusion that improved with guiding elastics.

Secondary orbital wall repair can be challenging, particularly if there has been any scarring. Six of the 12 patients who presented with enophthalmos needed orbital wall restoration using porous polyethylene sheets or a bone graft, according to research by He *et al*. The remaining three patients achieved normal globe position, while the other three remained enophthalmic and did not have any type of orbital wall restoration[5]. Of the patients in this research, 18 (4%) developed enophthalmos; 11 needed orbital wall restoration with autogenous iliac bone transplant; the other seven patients had follow-up care alone.

In this study, (Table 6), 41 (9.6%) patients had plate exposure. All of them received follow-up care, frequent saline irrigation, and plate removal following radiography confirmation of bone healing. Additionally, 33 (8%) patients had unsightly scars; the majority of these had their scars revised with excellent outcomes by plastic surgery.

CONFLICT OF INTEREST

There are no conflicts of interest.

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