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Radiological evaluation of sphenozygomatic suture fixation for restoration of orbital volume: A retrospective study

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ABSTRACT

Purpose: Lateral displacement of fracture zygomaticomaxillary complex (ZMC) can cause significant increase in orbital volume leading to enophthalmos. The aim of this study was to radiologically evaluate the efficacy of sphenozygomatic (SZ) suture fixation for restoration of orbital volume after elevation of the temporalis in cases of fracture ZMC where the fixation of zygomatic arch (ZA) was deemed necessary through latero-posterior approach.

Materials & methods: 43 operated cases of fracture ZMC using 4-point fixation were divided into two groups. Group I (n = 24) cases had undergone reduction and fixation of SZ suture as fourth point of fixation by elevating temporalis muscle using hemicoronal approach. Group II (n = 19) cases had undergone reduction and fixation of Infraorbital (IO) rim as fourth point of fixation using preseptal transconjunctival approach. Both the groups were analyzed separately and compared for restoring the increased orbital volume on CT.

Results: Difference in the pre-surgical orbital volume of both the groups was found to be statistically insignificant [p = .678]. In group I, the average bony orbital volume significantly reduced by 3.6 cc from 25.5 cc to 21.9 cc [p = .000] post-surgically. In group II, the average bony orbital volume reduced by 1.5 cc from 25.6 cc to 24.1 cc post-surgically There was a significant difference in the reduction of the increased orbital volume among the 2 groups (Group I: 3.6 cc, group II: 1.5 cc). The amount of reduction was more and statistically significant [p = .000] in the group I than group II.

Conclusion: SZ suture fixation is reliable in reducing fractures ZMC and restoring the increased orbital volume where the fixation of zygomatic arch (ZA) was deemed necessary through latero-posterior approach.

1. Introduction

The zygomatic bone is the most prominent bone in the upper lateral midface. The bone is solid and acts as a vertical and horizontal buttress. The fractures involving the zygoma are not usually confined to its strict anatomical boundaries but most often extend into adjacent maxillary and orbital structures. Therefore an appropriate terminology is Zygomaticomaxillary complex (ZMC) fractures (Ellis and Kittidumkerng, 1996). Fractures of the zygomatic arch (ZA) are often associated with ZMC fractures, but can also occur in isolation. Clinical sign and symptoms vary depending upon the type, extent, and degree/vector of displacement. Displacement of ZMC laterally along the vertical axis can cause significant increase in orbital volume, leading to enophthalmos. High-resolution computed tomography (CT) scans in axial, coronal, and sagittal sections with bone and soft tissue window provide a complete radiological visualization of the fracture, especially at the sphenozygomatic (SZ) suture region (Alsuhaibani, 2010). A step-ladder concept for ZMC and isolated arch fracture repair encompasses a variety of surgical routes from limited exposure to

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extended access according to the degree of fracture severity. The location and displacement of the fracture sites define the type and number of approaches needed to adequately treat a given ZMC fracture. The osteosynthesis concept also influences the treatment plan. Non-comminuted medially displaced ZMC fractures are typically approached anteriorly applying a 1- to 3-point fixation concept, depending on the degree of displacement, whereas comminuted laterally displaced fractures often require extended craniofacial approaches. The SZ suture line is ranked as the most reliable positioning guide in the reduction of isolated fractures of ZMC or in the rebuilding of the outer facial frame in major midface or panfacial trauma (Manson et al., 1999). Even if the zygomaticomaxillary buttress and the infraorbital (IO) rim are highly fragmented, comminuted, or present with bony defects, it is still possible to reduce the zygoma exactly by gap and pivot control at the SZ junction. In theory, 28 combinations of a 1-point up to a 5-point plating pattern exist. The indications to open and fix (IO) rim in fracture ZMC are the need for exploration of the orbital floor and communition zones at the lower vertical/inner horizontal buttresses (Cornelius, 2012). The purpose of this study was to evaluate the efficacy of SZ suture fixation after elevation of the temporalis muscle in cases of fracture ZMC in which the fixation of ZA was deemed necessary through a lateroposterior approach.

This is the first study on the SZ suture fixation in ZMC fractures in the existing oral and maxillofacial surgery literature. The study was based on the hypothesis that reduction and fixation of SZ suture would restore the increased volume of the bony orbit to its pre-injury state. The objectives were to measure the decrease in the increased volume of the bony orbit on CT and to draw a comparison with cases in which the above technique was not used.

The ideal orbital volume measurement method should be easily available, have a short learning curve, and take less time to perform. Various segmentation techniques are used for measurement of orbital volume, namely manual, threshold based, atlas based, and model based. Manual segmentation is an accurate technique in skilled and experienced hands in which the margins of the orbit are marked by the user in each image slice (Charteris et al., 1993; Lukats et al., 2012; Regensburg et al., 2008; Smith et al., 2007).

2. Materials and methods

An analytical, single-surgeon, retrospective study was designed from a population of patients who underwent fixation for fracture ZMC from 2008 to 2015. Institutional ethical committee approval was obtained before undertaking the study. Patients 18 years or more of age with 4-point fixed cases of fracture ZMC in which the fixation of ZA was deemed necessary through a lateroposterior approach with adequate pre- and postsurgery (CT) records available were included. The following criteria mandated fixation of zygomatic arch: (1) multifragmentation of the arch with lateral displacement of the middle section; and (2) fracture of the temporal arch root with tendency to telescope posteriorly. The following patients were excluded from the study: (1) patients with ZMC fractures in whom orbital floor reconstruction was required (in cases of disruption of internal orbit leading cosmetic deformity, soft tissue/muscle herniation and positive forced duction test) or carried out; (2) patients with any other midface fracture contributing to the change in the bony orbital volume; (3) patients with facial asymmetry; (4) patients with any previous history of fracture midface; (5) patients with impacted/medially rotated fracture ZMC where the volume of the bony orbit was decreased; and (6) patients with obvious misregistration artifacts on CT images. A hemicoronal approach was used to fix the zygomatic arch and frontozygomatic (FZ) suture region and upper vestibular approach for zygomatic buttress (ZB) region. In addition, either a preseptal transconjunctival incision was placed to address the IO rim as the fourth point of fixation (Fig. 1) or an SZ suture was reduced and used as the fourth point of fixation after elevating the temporalis muscle (Fig. 2). The choice of fourth point fixation was the IO rim only until 2012, after which the concept of sphenozygomatic reduction and fixation came into existence (Cornelius, 2012). All patients had undergone non-contrast-enhanced CT examination performed with a helical 16-slice Siemens Somatom Sensation 16 (Siemens, Erlangen, Germany). The images were obtained with 0.6-mm collimation, 1-mm thickness, and 1-mm increment at 180 mAs and 100 kVp. Each examination consisted of 25–30 contiguous slices through the orbit of patients; the axial sections were obtained at 0–10° from the orbito-meatal baseline. The patients were advised to fix their gaze at a point in the overhead gantry throughout the scan. Pixels representing area of interest in the structure within the prescribed density range were selectively counted. All of the bony apertures including the superior and inferior orbital fissures and the optical canal were excluded by drawing a line across them. A straight line connecting the medial and lateral orbital rims was designated as the anterior boundary of the orbit. The scan data were reformatted in the coronal and sagittal planes. The sectional area of the orbit was measured in each slice, and the orbital volume was calculated using the built-in image-measuring software in the system B (Fig. 3). A t test and paired t test were performed to assess the efficacy of each group in reducing the increased bony orbital volume and to draw comparisons between the two groups.

3. Results

A total of 43 documented records of 4-point fixation for fracture ZMC were identified as per the study criteria and divided into two groups. There was only one female patient in the entire study sample, with a 21.2-cc orbital volume of the unaffected eye. The average age was 31.14 years (range = 23–47 years, SD = 6.87) in the study sample. The average bony orbital volume of the unaffected side was 21.4 (range = 21.4–21.8 cc, SD = 0.4). Group I (n = 24) cases had undergone reduction and fixation of SZ suture as fourth point of fixation by elevating temporalis muscle using hemicoronal approach after reduction and fixation of ZA. Group II (n = 19) cases

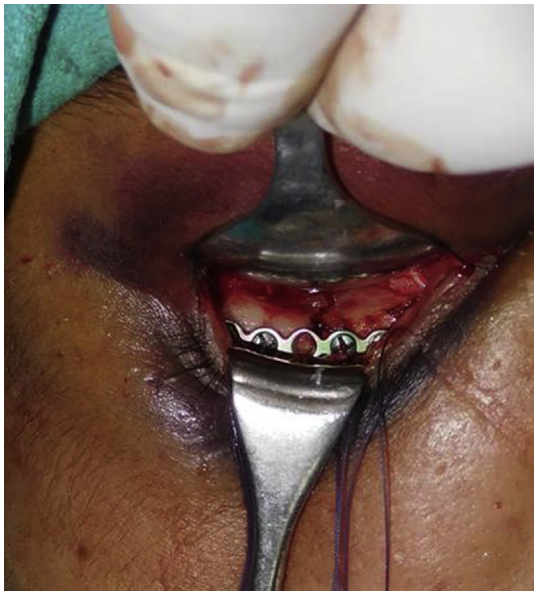

Fig. 1. Reduction and fixation of IO rim using preseptal transconjunctival approach.