Conventional versus Computer-Assisted Techniques for Reconstruction of Orbitozygomatic Fractures

Thesis

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DeDica tion

This piece of work is dedicated to
my parents and grandmother (who bless my life).
A special dedication to my husband; Adel Abou-ElFetouh,
my son Omar, my daughter; Yasmine
and my sisters; Maha and Hanan.

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LIST OF ABBREVIATIONS

2D	Two dimensional
3D	Three dimensional
ALT	Alanine Transaminase
ANOVA	Analysis of variance
AST	Aspartate Transaminase
CAD/CAM	Computer Aided Design/ Computer Aided Manufacture
CD	Compact Disc
CNC	Computer Numerical Control
CT	Computed Tomography
DICOM	Digital Imaging and Communication In Medicine
gr.	Group
HDPE	High Density Porous Polyethylene.
I.M.	Intramuscular
INR	International Normalized Ratio
LASER	Light Amplification by Stimulated Emission of Radiation
MRI	Magnetic Resonance Imaging
MVA	Motor Vehicle Accident
no.	Number

NOE	Naso-Orbito-Ethmoidal
PDS	Poly Dioxanone.
PT	Prothrombin Time
PTT	Partial Thromboplatin Time
SPSS	Statistical Package for Social Sciences
Std.	Standard
STL	Steriolithographic
UV	Ultra Violet

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Orbitozygomatic injuries need a multidisciplinary approach. Cases should be planned individually to reconstruct orbital structures, restore the cosmetic appearance and visual functions. Bony structures should be repositioned in their original place in space, soft tissues re-suspended where they used to be before the injury and scars should be revised. Complex posttraumatic orbital deformities might need multiple operations to correct, starting with a bony reconstruction[(1)].

Inaccuracy in reconstructing the orbitozygomatic complex may lead to impairment of function, such as diplopia, or unacceptable esthetics, such as cases of hypoglobus or enophthalmous. Achievement of this goal is sometimes very challenging due to the anatomical nature of this area.

The routine practice in planning such traumatic cases is mainly dependant on clinical and radiographic findings, including those presented as three dimensional (3D) radiographic data in computerized tomography (CT) scans.

Although the CT scans with the ability of reconstruction into three dimensional images are useful in giving an insight to the details of bony fractures, but alone they might not be enough for the transfer of the surgical plan accurately to the operating room. So, not until the development of surgical planning software accompanied with the ability of producing physical models has the transfer of a preoperative plan been possible, a practice that expanded in the past 2 decades[(2)]. The costs of such techniques may limit their use as a routine practice, except if they prove to be cost worthy, in terms of accuracy and significant improvement in the clinical outcome. Therefore a comparison of the conventional “free-hand” technique and "computer-assisted" techniques was deemed necessary to test the feasibility of the computer-assisted techniques in reconstruction of orbitozygomatic fractures.

The bony orbit resembles a quadrilateral pyramid which becomes three sided near its apex, with an average volume of 30 cm^3[3]. At the orbital rim the average horizontal dimension is 40 mm while the vertical dimension is about 35 mm, but the orbit is at its widest dimension 1cm behind the orbital rim[4]. The base of the orbit is anterior with a slight lateral and downward angulations while its apex orbit is shifted medially. The orbit is formed of seven bones, namely the maxillary, lacrimal, ethmoidal, sphenoidal, zygomatic, frontal and palatine bones[5,6] (*figure 1*).

The orbital rim acts as a thick gate to the thin roof, floor, medial and lateral walls of the orbital cavity, and this is of special significance in dissipating forces away[7]. The middle thirds of the orbital walls are thin and therefore are more prone to fracture[8].

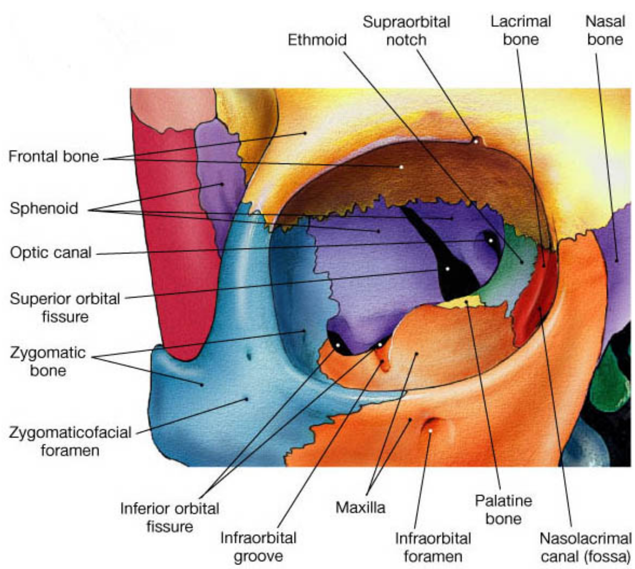

Figure 1: Different bones contributing to the bony orbit[9].

The orbital floor

The floor of the orbit slopes upwards posteriorly and is formed by the orbital process of the maxilla, the orbital process of the zygoma and posteriorly by part of the palatine bone[5]. It is often 0.5 mm thin. The lateral border of the floor is made by the inferior orbital fissure which separates the floor from the lateral wall posteriorly[10]. A safe subperiosteal dissection is considered 20 – 25 mm from the inferior orbital rim[6].

The infraorbital groove emerges from the middle of the inferior orbital fissure to run anteriorly. It originates 2.5 – 3 cm posterior to the inferior orbital rim, and transfers into a canal midway between the orbital rim and the inferior orbital fissure. Medial to the infraorbital groove, at the junction of the medial wall and the floor, the orbital floor is very thin due to the expansion of the maxillary sinus in this region[4]. Since the equator of the globe lies at or just behind the lateral orbital rim one can appreciate the value of the posterior region of the orbit and its contents in maintaining the anterior position of the globe[11].

The medial wall

The medial wall is formed, from anterior backwards, by the frontal process of the maxilla, the lacrimal bone, the ethmoid bone and the lesser wing of the sphenoid. The medial walls are parallel and about 2.5 cm apart. The thinnest part is the lamina papyracea (0.2 - 0.4 mm)[12], which is that part of the ethmoid air sinus covering the ethmoid air cells lying medially[4, 5]. A study was performed to analyze areas of the medial wall which are most prone to fracture, it was found that the anterior part of the lamina