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Case Report

Intraoperative imaging O-Arm™ in secondary surgical correction of post-traumatic orbital fractures

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A B S T R A C T

Purpose: To determine the safety and efficacy of O-Arm™ intraoperative imaging in maxillofacial surgery of post-traumatic orbital fractures. In order to ensure correct placement of titanium plate, immediately after fixing, viewable, in the axial, sagittal and coronal images.

Methods: The authors evaluated 5 consecutive adult patients with orbital fractures who required a reoperation involving displacement of titanium mesh between January and December 2015. The displacement or incorrect positioning of titanium mesh was detected at post-operative CT scan or clinical neurological findings. Intraoperative O-Arm™ imaging was used for our patients who underwent secondary maxillofacial orbital fracture surgery due to the failure of first surgical approach.

Results: An eyelid incision was performed in order to obtain maximal exposure and minimizing cosmetic defects. Any previous fixation device was skeletonized and removed, any improperly reduced fracture was mobilized, reduced and refixated with 1.5 mm plates, screws and titanium mesh. The intra-operative O-Arm™ imaging technique was used at the end of the procedures. In 4 cases it confirmed the appropriateness of the newly obtained reconstruction, in 1 case a first scan showed a suboptimal result and the devices were correctly repositioned, guided by the O-Arm™ images.

Conclusions: Intraoperative O-Arm™ assisted craniofacial reconstruction surgery improves the assessment of neurovascular structure decompression, skeletal fragment identification, fixation procedures and for the correct re-establishment of facial symmetry in orbital floor fractures.

1. Introduction

Orbital floor fractures are the most frequently injured areas in maxillofacial trauma and the major events involved are motor (80.9%) or sport accidents (14.2%), and direct pounding on the face (4.76%) [9].

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Diplopia, enophthalmos and blindness are the most common complications of orbital trauma and midface reconstruction and may become permanent if not treated [4]. Management of craniofacial injuries requires careful preoperative planning. It is also common practice for many neurosurgeons to obtain postoperative imaging to ensure the correct placement of the titanium plate. Therefore, computed tomography (CT) has become the gold standard for the diagnosis and radiological follow-up of maxillofacial injuries. Especially as, until now, it has only been possible to monitor the alignment of orbital floor fractures postoperatively with a CT examination with coronal sectioning. An incorrect positioning may require further surgical procedures or, eventually, cause damage to critical neurovascular structures. Intraoperative imaging allows the realization of a multidimensional anatomic map that provides, in cranial and spinal procedures, a guide for surgical decision making.

In recent years, the use of an intraoperative 3D anatomic imaging system: O-Arm™ (Medtronic Sofamor Danek, Memphis, TN, USA) has spread in spinal surgery [8]. The O-Arm™ is a full-rotation, multidimensional imaging system. It is a mobile CT scanner designed for intraoperative use, providing standard fluoroscopic images and 3-D volumetric CT scans. The O-Arm™ is compatible with conventional surgical tables, it allows for immediate real-time image guidance with multi-planar higher image resolution views. Although it is well described with regard to spine surgery, the use of the O-Arm™ in cranial surgical patients has been less commonly reported.

Careful understanding of the complex anatomy and relationship in craniofacial fractures and pathology is difficult with two-dimensional (2-D) imaging (for example, plain radiographs), on the other hand, three-dimensional (3-D) imaging modalities such as CT scans and MRI have become routine in the pre- and postoperative evaluation of craniofacial disorder.

The purpose of this study was to define the safety and efficacy of O-Arm™ imaging in cranial surgical patients with complex craniofacial post-traumatic deformities in which the first surgical approach failed.

2. Material and methods

We studied 5 adult patients with orbital fractures who consecutively required a re-operation due to displacement of the titanium mesh between January and December 2015. They underwent maxillofacial surgery using intraoperative O-Arm™ imaging and we have illustrated 2 of those cases in detail.

A single surgical team, including neurosurgeon and maxillo-facial surgeon, performed all surgeries. Patients included in the study agreed to use intraoperative imaging and surgical procedure simultaneously. Patient demographics, operative details, complications related to titanium plate placement, additional surgeries, and perioperative outcome were evaluated and compared with cases that underwent a conventional postoperative radiological follow-up after maxillofacial reconstruction. The scanning time with the O-Arm™ Imaging system was about 13 s (normal definition) with the head protocol: 120 kVp (kilovolts peak), varying mA (milliamperes), 1 rotation, 391 pulses of 10 ms each (beam-on time 3.91 s per acquisition) [2].

3. Surgical technique

After intubation and under general anesthesia, a Mayfield frame was positioned and the patient was placed in a supine position. A swinging eyelid incision (transconjunctival with lateral canthotomy) was performed to obtain maximal exposure while minimizing cosmetic defects. Wide underperiosteal dissection of the lateral wall, the floor and the medial wall of the fractured orbit and zygoma was carried out. Any previous fixation device was skeletonized and removed. Then, any improperly reduced fracture of the lower and/or lateral rim was mobilized, reduced and fixated using 1.5mm plates and screws. Then all fractures involving the orbit were managed. In detail, the herniated orbital content was reduced and the walls reconstructed with titanium mesh.

4. Illustrative cases

4.1. Case 1

A 37-year-old male with diplopia presented displacement of the left orbital titanium mesh. CT scan of the facial bone confirmed plate malpositioning. The patient had required surgical treatment for correction of the post-traumatic orbital left fracture three years earlier. The intra-operative O-Arm™ imaging technique was used and assisted us during all surgical procedure steps. Intraoperatively, we visualized (Fig. 1a,b,c) and removed the implants placed previously, then we repaired the walls of the orbit and confirmed the correct restoration of orbital structures (Fig. 2a,b,c). Pre-, intra- and post-operative (Fig. 3a,b,c) pictures were compared, indicating the correct placement of new titanium mesh and the clinical correction of diplopia was achieved.

4.2. Case 2

A 30-year-old female sustained a high-speed traffic accident injury 4 years earlier. She had been treated for a complex left orbital fracture elsewhere (Fig. 4a,b,c). Two years after the first operation, she underwent surgical removal of orbital mesh, as a CT scan follow-up had shown displacement of the plates and screws fixed in the orbital floor. When she came to our