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Case Report

Virtual surgical planning in post-traumatic zygomatic -orbital complex fracture: A case report

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ABSTRACT

The advent of technology shifted the paradigm in planning for complex craniofacial reconstructions. Zygomatic-orbital complex correction is performed efficiently by using pre-operative virtual planning, considering the difficulty in predicting the anatomical variances three-dimensionally. This case report describes the management of a patient reported for the correction of aesthetics three months post-trauma. It highlights the precision and accuracy obtained with virtual surgical planning in designing and fabrication of the stereolithographic models. Virtual surgical planning was done along with virtual surgery and a precise stereolithographic model was constructed on which the mock surgery was replicated to plan the surgical flow and predict the prognosis of the surgery. This concept of using virtual treatment planning and 3D printing of stereolithographic models makes this herculean correction of late post-traumatic zygomatic orbital complex deformities effortless. 3D Printing, Cloud based software algorithm, Computer-aided design, Stereolithography, Virtual Surgical Planning.

Keywords: 3D Printing; Cloud based software algorithm; Computeraided design; Stereolithography

1 INTRODUCTION

The field of oral and maxillofacial surgery has strengthened along with the advancements in technology to overcome all the setbacks faced previously. Virtual surgical planning is one such innovative approach that has found the forefront in this decade. Virtual surgical planning and computer-aided manufacturing have paved the way for the three-dimensional printing of the stereolithographic models, enabling the surgeons to interpret the actual surgeries like orthognathic, reconstruction, trauma, and microsurgery of the craniofacial skeleton. The success of these virtually planned cases depends on each and every step of the workflow process, performed with the help of 3D printed models and cloud-based software. This case report emphasis on treating a patient with post-traumatic zygomatic orbital deformities using virtual surgical planning to remodel the fractured bones accurately.

CASE REPORT

A 28-year-old male reported to the Department of Oral and Maxillofacial Surgery with the complaint of having facial deformity for the past three months. He presented a history of road traffic accident three months back under influence of alcohol and had lost his consciousness momentarily. He did not show any signs of seizure, vomiting, nasal or ear bleed after the accident and was immediately taken to a nearby local hospital. A computed tomographic (CT) scan was taken which revealed a subdural hematoma in the temporal lobe which was treated. The CT also revealed fracture of frontal bone, superior orbital rim, lateral orbital rim, inferior orbital rim, floor of orbit, lateral wall of orbit, optic foramen, zygoma, zygomatic arch and left coronoid fracture. [Figure 1]

He was then treated conservatively for head injury but did not get the fractures of the bones treated immediately because of personal reasons and was later discharged. He then started having trouble with his eyesight and was not pleased with his appearance and was consuming analgesics. He was referred to our department from a reputed eye hospital for aesthetic correction where he initially presented with complaints of blurred vision. After thorough history taking, it was found that the patient did not present with any relevant medical or dental history. But the patient has been a chronic alcoholic and smoker for the past

Fig. 1: CT Scan of the patient depicting the fractured bones

ten years. Clinical examination was done, and the patient presented with facial asymmetry because of posterior and downward displacement of the left frontal, orbital rim, medial displacement of the lateral orbital rim along with loss of contour in the malar region. He had restricted mouth opening (30mm). On inspecting both the orbits, there was a presence of diplopia during downward and right-side gaze along with displaced ocular globe position. Palpation of the orbit revealed tenderness over the lateral canthal region. CT findings showed the left globe was displaced medially and inferiorly. The CT orbital volume was measured to 31.23cc of left orbit in comparison to the normal orbit 24.12cc. Volume difference of more than 5.6cc confirms enophthalmos (1cc increase equals 0.8mm of enophthalmos). [(1)]

Further interaction with the ophthalmologist revealed that the clinical enophthalmos measurements are actually different. With Hertels exophthalmometry, the measurement of left eye is 3 mm more than the right eye because of the lateral wall fracture (and hertels is placed on the deepest part of lateral orbital rim). There was mydriasis and unequal position of the right and left pupil because of downward displacement of the left globe which restricted the upward gaze along with enophthalmos of about 3mm. Presence of a traumatic neuropathy of the optic nerve and entrapment of the inferior orbital soft tissue was found in the CT. Ophthalmic opinion was that the ocular motility may not improve much, however there can be very minimal functional improvement. For this patient, post traumatic deformity correction is essentially aesthetic. After explaining to the patient about the possible surgical outcome, the virtual planning was proceeded with his consent. Given the severity of the fracture, it was an ideal case to approach with virtual surgical planning. [(2)] All the patient data was uploaded to a cloud-based software algorithm which enabled us to interpret and visualize the fractures with precision. OSTEO - 3D was the software used for this case. Digital surgical planning was done where the deficit in the left orbital volume was noted. It numbered all the fractured segments from 1 to 6 [Figure 2] and the amount of displacement both in millimetres and angulations was interpreted using this software. [Table 1]

Fig. 2: Virtual Surgical Planning - Fractured segments are numbered(1-6)

Table 1:

Segments	Displacement	Rotation
1	2.07mm to the left	13.19° clockwise from front
2	5.38mm upward, 2.15mm to the left, 8.54mm forward	1.6° anticlockwise from front
3	3.42mm upward, 0.97mm left, 7.9mm forward	4° from top anticlockwise 5.3° clockwise from front
4	4.05mm upward, 2.79mm to left, 5.50mm forward	–
5	2.35mm to left, 1.98mm to left, 3.98mm forward	4.6° anticlockwise from front, 8° clockwise from top
6	3.26mm to left, 0.29mm downward, 3.13mm forward	18.9° anticlockwise from front, 15.9° anticlockwise front top

This software enabled the surgeons to go through the entire surgical procedure preoperatively and plan the workflow and perform virtual surgery. It aided in visualization of the fractured segments in various aspects along with the adjacent neurovascular structures, which was helpful in preventing postoperative complications. The CAD CAM technology was used in designing the stereolithographic model, [Figure 3] replicating the patient's deformities and was printed, which helped the surgeon to practice the surgical workflow through a mock surgery. The fractured and displaced segments as numbered by the software was marked and each of these segments was reduced according to exact value and angulation. [Figures 4, 5 and 6] The best approach to access the fractured segments was interpreted and the surgery was done by using an intraoral and lateral canthal incisions and the orbital fracture segments were reduced as interpreted by the virtual surgery starting with the lateral orbital wall, frontal bone, supraorbital rim, medial wall of the orbit and floor of the orbit. The zygomatic arch was elevated using Gille's temporal approach. The virtual surgical planning played a crucial role in this perplexing case and aided the surgeon to perform the surgery diligently, well ahead of time. The patient did not report with any postoperative complications and was satisfied with the result.[3] The entire process of virtual surgical planning was accomplished within a span of one week.

Fig. 3: Stereolithographic model depicting patient deformities

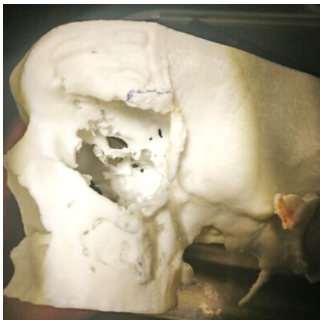

Fig. 4: Mock surgery - Fractured segments are removed for propervisualization

Figure 4 Mock surgery — Fractured segments are removed for proper visualization

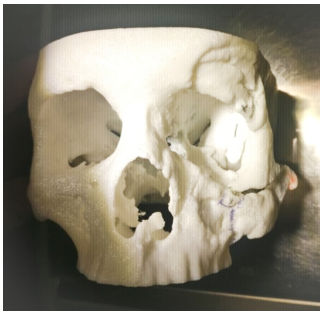

Fig. 5: Fracured fragments are reduced and deformities are corrected– Frontal view

2 DISCUSSION

As put forward by Alan Scott Herford et al., Virtual surgical planning (VSP) has recently been introduced

Fig. 6: Fracured fragments arereduced and deformities are corrected – Lateral view

in craniomaxillofacial surgery to improve efficiency and precision for complex surgical operations.[4] Among the many indications, virtual surgical planning is used for congenital and acquired craniofacial defects, including orbital fractures. VSP, as briefed before, allows the surgeon to visualize the anatomy of the craniofacial region, including the relationship between complex anatomic and neurovascular structures. With the assistance of VSP, the complex fracture region is visualized, virtual surgery is performed to assess the patient deformities and the best surgical approach is determined. This approach is practised on the stereolithographic models and then on the patient. As Huang YH briefed in his case report about the benefits contributing to greater predictability and improved treatment efficiency of VSP, in this case, was more reliable outcomes in surgical reconstruction were achieved.[5] The use of virtual surgical planning to picture the fractured orbit and adjacent structures and interpret the amount of displacement in delayed reconstruction cases was previously well explained by Stranix et al. in their paper.[6] As explained previously, this case report stands as a testament that virtual surgery and the mock surgery guided the surgeons to perform the surgery with precision and was done well within the stipulated time with no issues.[7] On discharge, the patient was asked to report after three weeks but he did not report back for any post-operative investigations.

3 SUMMARY

Complex surgical procedures has always been a task for surgeons. The strengthening technology has empowered the surgeons through various innovations and one such is the virtual surgical planning. This case report explained the post-traumatic zygomatic orbital complex fracture reconstruction done with the help of virtual surgical planning. With all the information, the surgery was performed and the patient aesthetics and functional abilities were restored. This case proclaims the use of virtual surgical planning and how it has helped us to reckon the trauma region and provide the best surgical option for the patient. Use of this virtual planning is still negligible for craniofacial surgeries, but this case affirms the use of virtual surgical planning for the betterment of both the patient and the surgeons. As an endnote, the clinician's knowledge and prompt use of the virtual surgical planning method helped us perform this surgery hassle-free.

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