Case Report
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ORCID
Kyu Nam Kim: orcid.org/0000-0001-9998-8722
Hoon Kim: orcid.org/0000-0003-1261-9743

Reconstruction of the Inferior Orbital Wall with Simplified Simulation Technique in Case of the Fracture Extending to the Posterior Orbital Floor

Kyu Nam Kim, M.D., Hoon Kim, M.D.

Department of Plastic and Reconstructive Surgery, Konyang University Hospital, College of Medicine, Daejeon, Korea

A 37-year-old male was assaulted and complained of severe periorbital swelling. Physical examination revealed that there were limitation of eyeball movement on upper gaze, diplopia, and hypoesthesia on the infraorbital nerve innervating region. Three-dimensional (3D) computed tomography (CT) of facial bone exhibited the fracture of orbital floor accompanying the significant amount of orbital contents' herniation extending to the far posterior part. To recover the orbital volume and restore orbital floor without threatening the optic nerve, preoperative simplified simulation was applied. The posterior margin of the fractured orbit was delineated with simulation technique using cross-linkage between the coronal and sagittal sections based on the referential axial view of the CT scans. Dissection, reduction of orbital contents, and insertion of the absorbable mesh plate molded after the prefabricated template by the simulation technique was performed. Extensive orbital floor defect was successfully reconstructed and there were no serious complications. The purpose of this report is to emphasize the necessity of preoperative simulation in case of restoring the extensive orbital floor defect.

Key Words Orbital floor fracture · Simulation technique.

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Address for correspondence: Hoon Kim, M.D.
Department of Plastic and Reconstructive Surgery, Konyang University Hospital, University of Konyang College of Medicine, Myunggok Medical Research Center, 158 Gwanjeodong-ro, Seo-gu, Daejeon 35365, Korea
Tel: 82-42-600-9210, **Fax:** 82-42-600-9090, **E-mail:** prshoonkim@gmail.com

Introduction

Orbital fracture, also known as a blow-out fracture, is a commonly encountered craniofacial trauma (1). Medial and inferior orbital wall have been well known to be the frequently involved locations in case of pure blow-out fracture. Non-surgical conservative care can be considered to the patients with minimal protrusion of orbital contents and relatively good eyeball excursion.

However, surgical intervention is mandatory for the patients having diplopia with limitation of extraocular motion due to the incarcerated muscle, radiologic evidence of extensive fracture, and significant enophthalmos (2-4). In particular, widespread herniation of orbital contents into the maxillary sinus in the patients with orbital floor fracture can cause late enophthalmos. Therefore, this has been regarded as one of the most significant factors for considering surgical intervention.

When it comes to the surgical perspective, approaching to the far posterior margin of the orbital floor fracture has always given rise to a concern for the fear of feasible damage to the optic nerve. To avoid this apprehension, we performed preoperative simplified simulation to proceed the safe and complete orbital reconstruction involving the far posterior area of the orbital fracture.

A Case Report

A 37-year-old male was brought to the emergency department complaining of the severe periorbital swelling and tenderness caused by human assault. In addition, physical examination showed the double vision, limitation of eyeball movement on upgaze, and numbness around the left cheek. To evaluate the associated symptoms, facial bone CT with 3D reconstruction was performed. Extensive orbital floor fracture reaching the far posterior region was identified. Otherwise, there were no definite relevant abnormal findings including orbital rim fracture (Figs. 1, 2).

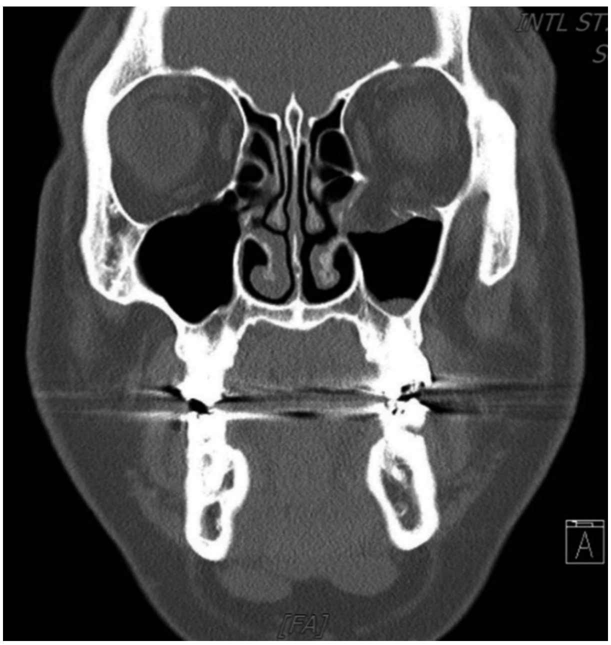

Fig. 1. Coronal view of the preoperative facial bone CT with 3D reconstruction shows the extensive orbital floor fracture with definite herniation of orbital contents in the patient's left orbit.

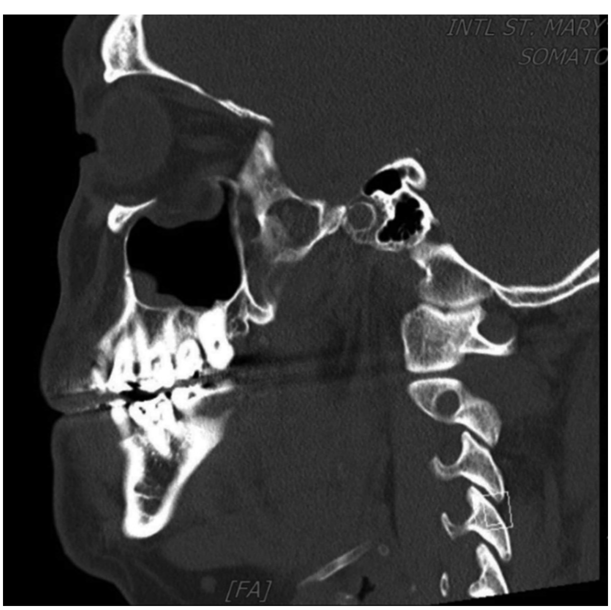

Fig. 2. Sagittal view of the preoperative facial bone CT with 3D reconstruction shows the fracture extended to the far posterior boundary of the orbital floor.

Surgical treatment was planned to recover the orbital volume without threatening the optic canal. To obtain this purpose, preoperative simplified simulation was planned.

Margin of the fractured orbit was delineated with simulation using cross-linkage between the coronal and sagittal sections based on the corresponding referential axial CT section view. (Fig. 3A) Posterior boundary of the fracture was defined using Hounsfield unit (HU). HU over 600 was regarded as the remnant bony portion.

The distance from the orbital rim to the posterior border of fractured orbit was estimated using the 'Measurement tool' of the PACS system (INFINITT® PACS, Republic of Korea). With every 3mm axial slices of CT scan, cross-linked serial measurement was made to approximate the whole dimension of the orbital fracture (Fig. 3B).

Once the orbital defect area was estimated, prefabricated template was made from the reusable Esmark (Latex-free bandage) sterilized by the Ethylene Oxide gas (Fig. 4).

Through the transconjunctival incision, reduction of orbital contents and insertion of the absorbable mesh without pores (OSTEOTRANS-MX®, TAKIRON, Japan) trimmed along the sterilized prefabricated template (20×27 mm) after simulation technique were performed for the reconstruction of the orbital floor.

Safe and complete orbital floor reconstruction was achieved without serious complication including optic nerve injury or orbital apex syndrome (Figs. 5, 6).

Clinical symptoms except sensory disturbance on the infraorbital nerve innervating region were completely resoluted immediately after the surgery. Paresthesia around the cheek area was spontaneously resolved in postoperative 6 months. Otherwise, no ocular symptoms remained.

Discussion

Orbital fracture usually implicates the medial and inferior wall because of their thin bony layer as well as the anatomical friability. Most of the orbital floor fracture occurs in the mid 1/3 portion due to the buffering and absorbing effect of the external impact.

Close observation with non-surgical treatment can be indicated if the patient had no ocular symptoms, no radiologic finding of extensive fracture, and lack of evidence predicting the enophthalmos.

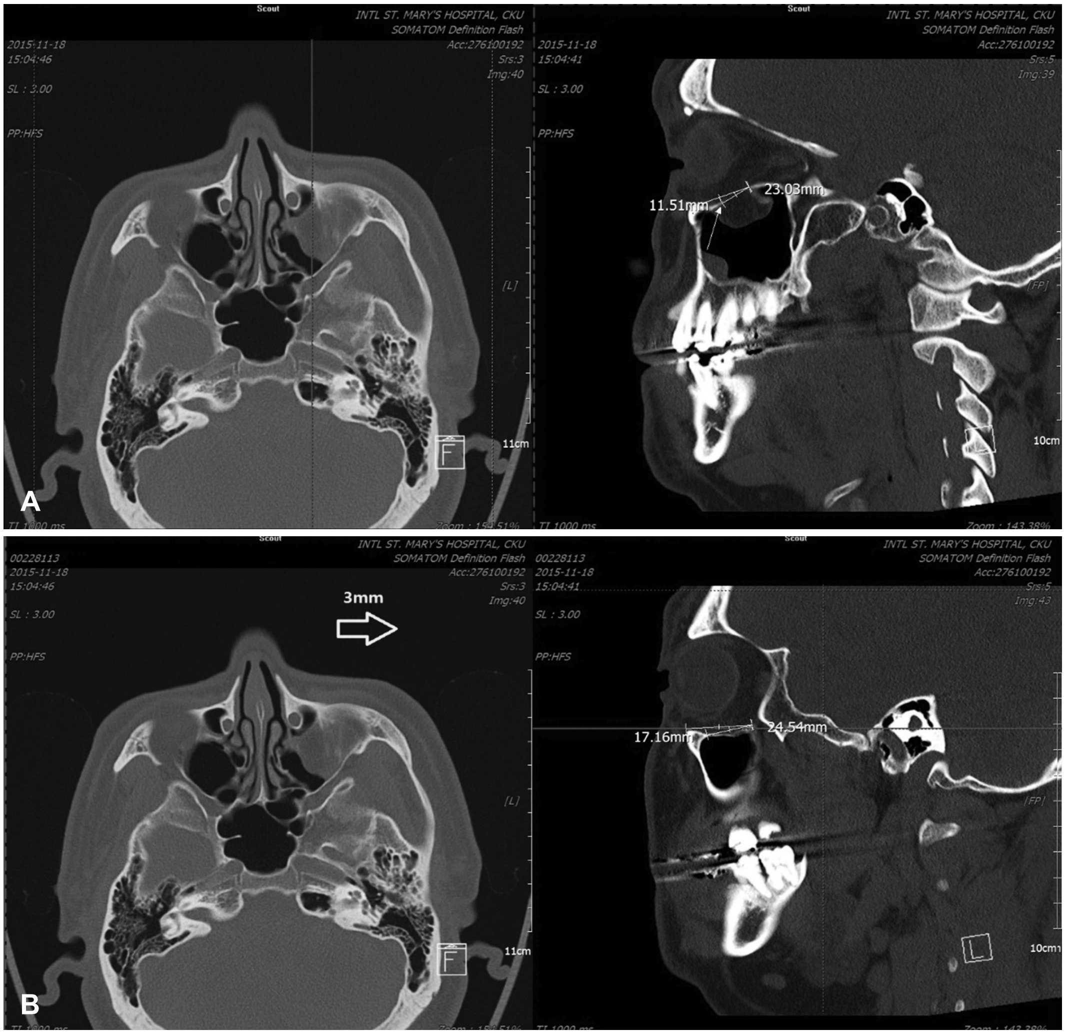

Fig. 3. A: Margin of the fractured orbit was delineated with simulation using cross-linkage between the coronal and sagittal sections based on the corresponding referential axial CT section view. B: With every 3mm axial slices of CT scan, cross-linked serial measurement The distance from the orbital rim to the posterior boundary of fractured orbit was made to approximate the whole dimension of the orbital fracture.

However, surgical intervention should be considered in case of extensive fracture due to possible development of late enophthalmos. In particular, to restore the fracture with huge orbital volume herniation into the maxillary sinus is always challenging as it contains the risk of injury to the optic nerve as well as feasible development of iatrogenic orbital apex syndrome, both of which can be disastrous.

To avoid these complications while achieving the effective orbital floor reconstruction, numerous state-of-the-art techniques have been introduced (5-7). However, these advances have encountered the hindrance of the cost-effective market logic especially in the low medical fee insurance system.

We tried to overcome these hurdles with simplified simulation technique taking advantage of the preexisting PACS system. With the 'Cross-linkage' and 'Measurement' tool in the INFINITT® PACS system, we approximated the border of fractured orbital floor by means of HU. This prototypical technique aimed to mimic the navigation system of providing an imaginary coordinates. With this sort of simulation, we could obtain the distance from the orbital rim to the posterior margin of the fracture. Then the prefabricated template was made from reusable Esmark (Latex-free bandage) sterilized by the Ethylene Oxide gas.

These integral preoperative simulation rendered us a safe intraoperative approach to the far posterior part of the fracture without endangering the optic nerve or causing unwanted orbital apex syndrome. Despite the less accuracy ascertained than the current 3D printing or other emerging techniques, our method is still worthy of trying as it is simple and cost-effective without needing up to date equipments.

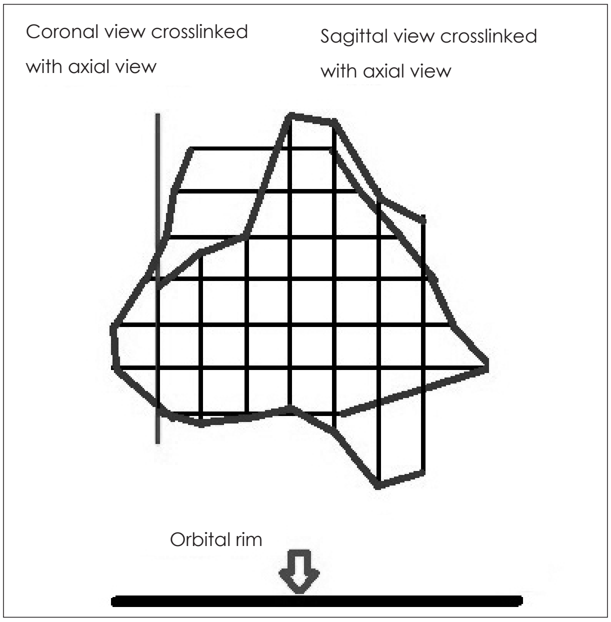

Fig. 4. Prefabricated template was made from the reusable Esmark (Latex-free bandage) sterilized by the Ethylene Oxide gas.

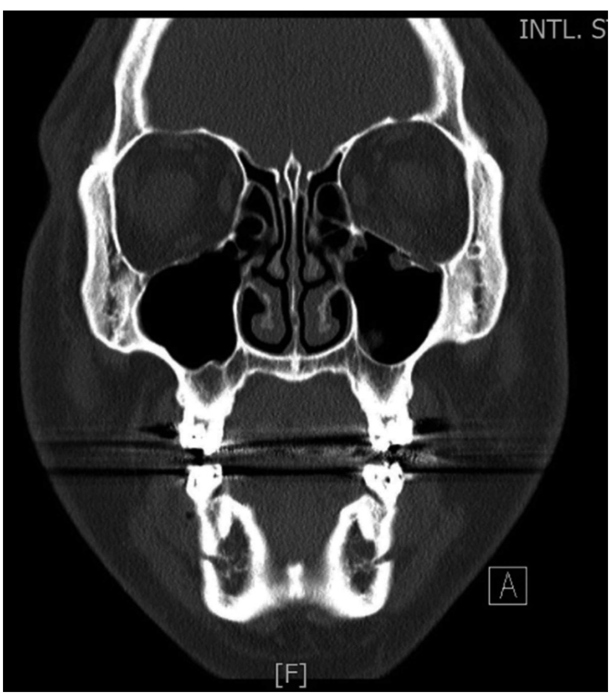

Fig. 5. Note the complete reduction of the herniated orbital contents in postoperative coronal view of the CT scans.

Conclusion

With regard to the surgical intervention of large volume protrusion in the orbital floor fracture, posterior margin of fracture in the vicinity of the optic canal is always challenging. Therefore, preoperative simplified simulation technique would better be taken into account to ensure the secure surgical outcome in case of extensive orbital floor fracture.

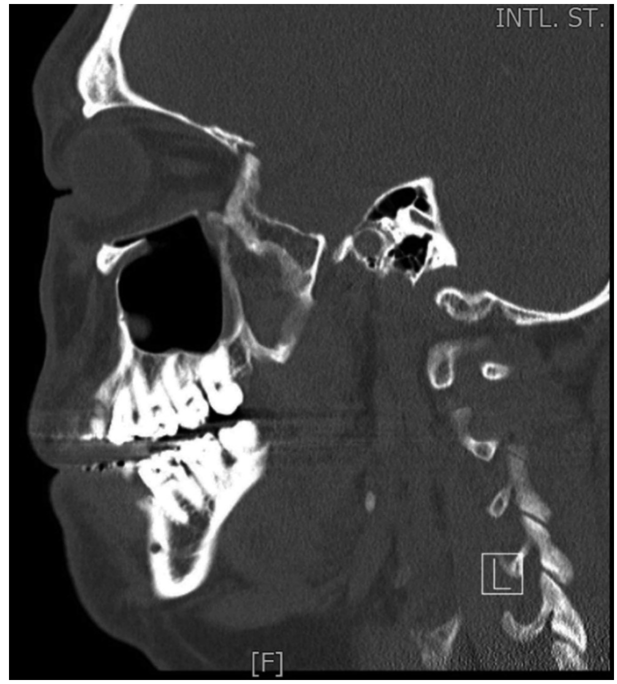

Fig. 6. Note the successful reconstruction using the absorbable mesh plate after the prefabricated template successful reconstruction including far posterior orbital floor with the absorbable mesh plate (20×27 mm) after the prefabricated in postoperative sagittal view of the CT scans.

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