# Outcomes of Orbital Floor Reconstruction After Extensive Maxillectomy Using the Computer-Assisted Fabricated Individual Titanium Mesh Technique

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**Purpose:** Orbital floor defects after extensive maxillectomy can cause severe esthetic and functional deformities. Orbital floor reconstruction using the computer-assisted fabricated individual titanium mesh technique is a promising method. This study evaluated the application and clinical outcomes of this technique.

**Patients and Methods:** This retrospective study included 10 patients with orbital floor defects after maxillectomy performed from 2012 through 2014. A 3-dimensional individual stereo model based on mirror images of the unaffected orbit was obtained to fabricate an anatomically adapted titanium mesh using computer-assisted design and manufacturing. The titanium mesh was inserted into the defect using computer navigation. The postoperative globe projection and orbital volume were measured and the incidence of postoperative complications was evaluated.

**Results:** The average postoperative globe projection was 15.91 ± 1.80 mm on the affected side and 16.24 ± 2.24 mm on the unaffected side ($P$ = .505), and the average postoperative orbital volume was 26.01 ± 1.28 and 25.57 ± 1.89 mL, respectively ($P$ = .312). The mean mesh depth was 25.11 ± 2.13 mm. The mean follow-up period was 23.4 ± 7.7 months (12 to 34 months). Of the 10 patients, 9 did not develop diplopia or a decrease in visual acuity and ocular motility. Titanium mesh exposure was not observed in any patient. All patients were satisfied with their postoperative facial symmetry.

**Conclusion:** Orbital floor reconstruction after extensive maxillectomy with an individual titanium mesh fabricated using computer-assisted techniques can preserve globe projection and orbital volume, resulting in successful clinical outcomes.



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Maxillary defects created after tumor ablation can cause severe functional and esthetic deformities. The orbit is located adjacent to the maxillary bone, and the orbital floor often requires removal, if involved. Orbital floor defects also result in esthetic and functional deformities, including enophthalmos, hypophthalmos, diplopia, and impaired visual acuity. The reconstruction of post-traumatic orbital defects has been well documented in recent years.[1-3] However, the reconstruction of total orbital floor defects after extensive maxillectomy remains a challenge for surgeons.

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Currently, various types of materials, such as titanium meshes, hydroxyapatite, silica gel, Teflon, and Medpor, and autogenous bones, such as the iliac and cranial bones and ribs, are used for orbital reconstruction.[4-8] However, reports on the reconstruction of orbital floor defects resulting from tumor resection are few. Furthermore, the irregular contour of the orbit makes it difficult to precisely rehabilitate orbital defects, and complications, such as diplopia, malpositioning of the globe, restriction of ocular motility, and a decrease in visual acuity, become inevitable in some cases. Although the use of a titanium mesh, which is flexible and can easily simulate the orbital bone structure, is well accepted as the primary choice for orbital fracture repair, there are no reports on its use for orbital floor reconstruction after maxillary tumor resection.

Computer-assisted design and manufacturing techniques combined with intraoperative navigation have been widely used for various craniomaxillofacial surgeries.[9-11] Preoperative designing and intraoperative navigation can provide additional accuracy and safety during orbital floor reconstruction, with improved clinical outcomes. The aim of this study was to evaluate the clinical procedure and outcomes of orbital floor reconstruction after extensive maxillectomy using the computer-assisted fabricated individual titanium mesh technique.

## Patients and Methods

### PATIENT DEMOGRAPHICS

This retrospective study included 10 consecutive patients (5 men and 5 women; mean age, 42.1 yr; age range, 9 to 75 yr) who underwent orbital floor reconstruction using an individual titanium mesh fabricated using computer-assisted techniques after maxillectomy at the authors' institution from April 2012 to March 2014. This study followed the Declaration of Helsinki on medical protocol and was approved by the institutional ethic committee and review board. All patients were diagnosed with maxillary tumors requiring resection with extensive maxillectomy including the orbital floor. The tumors were benign in 4 patients and malignant in 6. None of the patients presented with ocular symptoms, such as diplopia, enophthalmos, impaired visual acuity, and restricted globe movements. All orbital defects were limited to the orbital floor. The primary maxillary defects were restored with a free fibula flap (n = 4), an anterior lateral thigh flap (n = 5), or a rectus abdominis muscle flap (n = 1), and the orbital floor defects were reconstructed with an individual titanium mesh fabricated using computer-assisted techniques (Table 1).

### VIRTUAL SURGICAL PLANNING

All patients underwent spiral computed tomographic (CT) scanning of the head and neck region before surgery (field of view, 20 cm; pitch, 1.0; slice, 0.75 mm; 120Y280 mA), and all imaging data were imported to iPlan CMF (BrainLAB, AG, Feldkirchen, Germany) and ProPlan CMF (Materalise, Leuven, Belgium). Then, tumor resection and maxillectomy were simulated on the computer. A 3-dimensional image of the orbital floor was reconstructed from a mirror image of the unaffected side (Fig 1), after which a 3-dimensional resin stereo model was printed based on the mirror image using rapid prototyping

**Table 1. PATIENT CHARACTERISTICS (N = 10)**

| Patient Number | Gender | Age (yr) | Affected Side | Primary Diagnosis | Reconstruction Option | Recurrence | Adjuvant Treatment | Follow-Up (mo) | Outcome |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 75 | Right | Adenocarcinoma | ALTF | No | None | 34 | ANED |
| 2 | M | 71 | Left | Myoepithelial carcinoma | ALTF | No | None | 30 | ANED |
| 3 | F | 10 | Left | Ameloblastoma | ALTF | Yes | Surgery | 30 | AWD |
| 4 | M | 51 | Right | Osteosarcoma | FFF | Yes | Rad + chemo | 12 | DOD |
| 5 | F | 18 | Left | Osteofibroma | FFF | No | None | 27 | ANED |
| 6 | M | 9 | Left | Osteosarcoma | RAMF | No | None | 27 | ANED |
| 7 | F | 56 | Left | Adenoid cystic carcinoma | ALTF | Yes | Rad + GKR | 26 | AWD |
| 8 | M | 31 | Left | Osteofibroma | FFF | No | None | 18 | ANED |
| 9 | M | 75 | left | Osteosarcoma | ALTF | No | None | 16 | ANED |
| 10 | F | 25 | Right | Myxoma | FFF | No | None | 14 | ANED |

Abbreviations: ALTF, anterior lateral thigh flap; ANED, alive without evidence of disease; AWD, alive with disease; chemo, chemotherapy; DOD, dead of disease; F, female; FFF, free fibula flap; GKR, gamma knife radiosurgery; M, male; Rad, radiotherapy; RAMF, rectus abdominis muscle flap.

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