Reconstruction of Extensive Maxillary Defects Using Zygomaticus Implants

Brian L. Schmidt, DDS, MD, Ph.D.,* M.A. Pogrel, DDS, MD, FRCS,† Carl W. Young, DDS, MD,‡ and Arun Sbrero, DDS, MS§

Purpose: Maxillary reconstruction after maxillectomy remains a great challenge for the reconstructive oral and maxillofacial surgeon. This article is a clinical retrospective analysis of patients reconstructed with zygomaticus implants after maxillary ablation.

Patients and Methods: The design of the study was a retrospective review of 9 patients requiring near-total or total maxillectomy for pathologic reasons. Clinical records, photographs, and radiographs were studied. Financial billing statements were reviewed to determine charges for implant reconstruction and method of payment.

Results: Maxillary reconstruction using zygomaticus and standard endosseous implants was performed in 9 patients. Maxillary resection was performed for the following reasons: salivary gland malignancy (n = 2), squamous cell carcinoma (n = 5), maxillary mucormycosis (n = 1), and extensive maxillary atrophy and infection secondary to subperiosteal maxillary implant placement (n = 1). A total of 28 zygomaticus implants and 10 standard endosseous implants were used to reconstruct the 9 patients. Six zygomaticus implants and 3 standard endosseous implants failed. The time of zygomaticus implant placement ranged from placement at the time of resection to 3.2 years after the resection. Five patients received radiation therapy. Five patients have been reconstructed with a maxillary obturator and have been functioning with the prosthesis for a minimum of 2 years.

Conclusion: The combination of zygomaticus and standard endosseous implants can be used to reliably reconstruct patients after extensive resection of the maxilla.

Available maxillary reconstructive techniques include placement of a prosthetic obturator, local and regional flaps, and microvascular free flaps.1,3 The different reconstructive techniques have specific indications and advantages depending on the ablative defect, the medical status of the patient, and the patient’s prognosis. The maxillary obturator has a long history of effectively managing the functional, cosmetic, and psychological problems associated with a maxillectomy defect. However, when extensive resections are required, significant problems with obturator retention, support, and stability can be encountered after the ablation of retentive maxillary anatomy. Zygomaticus implants were originally designed for reconstruction of the atrophic, edentulous maxilla.6 Zygomaticus implants have also been used to establish retention and support for a maxillary prosthesis after maxillectomy. However, to date there has not been a review of patients reconstructed with zygomaticus implants after maxillectomy. The purpose of this study was to review the clinical outcome of patients who have had maxillectomy for pathologic reasons and have been reconstructed with zygomaticus implants.
Patients and Methods

The design of this study was a retrospective review. Nine patients treated with zygomaticus implants and standard endosseous implants after maxillary resection were evaluated. The surgical and prosthodontic records, radiographs, and clinical photos were reviewed to obtain the following information: patient demographics, pathologic reason for maxillectomy, extent of maxillary resection, number of zygomaticus and standard endosseous implants placed, number of implants that failed, time from resection to implant placement, requirement for radiation therapy, and prosthetic outcome. Financial billing statements were reviewed to determine the charges and source of payment for implant placement.

Results

A total of 9 patients with extensive maxillary resections were reconstructed with a combination of 28 zygomaticus and 10 standard endosseous implants (Table 1). The indications for extensive maxillectomy included mucormycosis (Fig 1), salivary gland malignancy (Fig 2), squamous cell carcinoma, and extensive maxillary atrophy and infection after placement of a subperiosteal implant (Table 1). Patients were either reconstructed with a combination of zygomaticus and standard endosseous implants (Figs 1, 2) or double bilateral zygomaticus implants (Fig 3) alone if no maxillary bone was available for placement of standard endosseous implants. Six of the 28 zygomaticus and 3 of the 10 standard endosseous implants have failed (Table 1). All failures occurred at stage II implant surgery. The time of implant placement, history of radiation therapy, and prosthetic outcome are listed in Table 2. One patient had 60 Gy of radiation to the anterior maxilla 23 years before implant placement. Four patients had radiation therapy approximately 2 weeks after placement of the implants. Five of the 9 patients have been fully reconstructed with a maxillary obturator with excellent speech, swallowing, and aesthetics. These 5 patients have been functioning with the prosthesis for 2 to 3 years with no loss of implants. Two remaining patients are in the process of osseointegration of the implants before construction of the maxillary obturator. Two patients have died from malignancy. Table 3 lists the charges and source of payment for all implants. The total professional fee for placement of 28 zygomaticus and 10 standard endosseous implants was $56,905 minus the surgery center or operating room charge. Eight of 9 patients were required to pay for the implants out-of-pocket. Medical insurance payment for the implants, hospital charges, and prosthodontic charges was received for 1 patient. All cases were performed with general anesthesia in the surgery center or operating room.

Discussion

To the best of our knowledge this study is the first to evaluate clinical outcome after maxillary reconstruction with zygomaticus implants after extensive maxillectomy. We found that the combination of zygomaticus and standard endosseous implants can be used to retain and support a maxillary obturator after extensive resection of the maxilla. Twenty-one percent of zygomaticus and 30% of standard endosseous implants failed. This failure rate is higher than tradi-
tionally encountered, and there are a number of possible explanations for implant failure in patients after extensive maxillectomy.

One likely explanation for zygomaticus implant failure after extensive maxillectomy is radiation therapy. Two of the 3 patients who experienced zygomaticus implant failure had received radiation therapy. One patient received radiation over 3 years before implant placement and 2 patients had implants placed at the time of resection and radiation therapy was started 2 weeks later. Radiation has a clear impact on the reparative capacity of bone. It has been previously shown that the success rate for standard endosseous implants is lower in the irradiated oral and maxillofacial region. Parel and Tjellstrom reported a success rate of only 61.1% for craniofacial implants placed in irradiated bone. There has not been a study published that answers the question of whether implants should be placed before or after radiation therapy.

The issue of hyperbaric oxygen therapy in patients having implant reconstruction after radiation therapy is also controversial. Our current protocol is to place the zygomaticus implants at the time of resection given that most patients will require radiation therapy within 2 to 3 weeks of maxillary resection. In the single patient that we placed zygomaticus implants after radiation therapy, the time of implant placement was over 3 years after radiation therapy and hyperbaric oxygen therapy was not given. Two of 4 zygomaticus implants and 1 of 2 standard endosseous implants failed in this patient. Despite these implant failures the patient could be reconstructed with the remaining 2 zygomaticus and 1 standard endosseous implants. The patient has been functioning with the obturator for 3 years. Given the possibility of implant failure in these patients, we place as many standard and/or zygomaticus implants as dictated by the available bone.

FIGURE 1. Reconstruction of an extensive maxillary defect with zygomaticus and standard endosseous implants after resection for maxillary mucormycosis. A, The patient initially presented with a small draining fistula involving the left maxilla. B, The patient was taken to the operating room for biopsy. The entire maxilla was noted to be necrotic. The microbiologic diagnosis demonstrated mucormycosis. C, Extensive resection of the maxilla, including the piriform rims and buttress regions, was required. After resection there was little remaining maxilla and a denture could not be supported. D, The patient was reconstructed with 4 zygomaticus implants. One standard endosseous implant was placed in the left piriform rim region.

Another possible explanation for implant failure is that the biomechanical forces placed on zygomaticus and standard implants after an extensive maxillectomy are significantly greater than the forces observed in a conventional implant reconstructive case. The quality and quantity of remaining bone available for osseointegration after an extensive maxillectomy are compromised. The lever arm placed on zygomaticus implants is significantly greater than the lever arm placed on standard endosseous implants. In most of the cases in this study, resection of the palatal bone was required. Therefore, the only bone available for integration of the zygomaticus implant is the zygomatic bone at the junction of the temporal and frontal process. Additionally, with standard endosseous implants the occlusal force is generally parallel to the long axis of the implant. In the case of zygomaticus implants the implant is at a 30° to 60° angle relative to the occlusal force. These biomechanical requirements possibly contribute to zygomaticus implant failures in patients after extensive maxillectomy. One finding from this study that argues against biomechanical factors as the etiology of failure is that all implant failures occurred at stage II surgery, before loading.

Reconstruction of near-total maxillectomy defect after resection for adenoid cystic carcinoma. A, Biopsy-proven adenoid cystic carcinoma involving almost the entire maxilla. B, The panoramic radiograph shows evidence of maxillary osteolysis. C, A near-total maxillectomy was performed. D, Intraoperative view. The maxillary alveolus and buttresses and a portion of the nasal septum were resected. E, A postoperative axial computed tomography shows the extent of maxillary resection required. The pterygoid plates were retained. Postoperatively, a denture could not be retained given the loss of retentive maxillary anatomy. The patient had significant problems with nasal regurgitation. F, Postreconstruction panoramic radiograph. Bilateral zygomaticus implants were placed, and a standard endosseous implant was placed into the left pterygoid plate.

This finding further points to radiation therapy as a contributing factor to implant failures in these cases.

In this study we did not evaluate quality of life after maxillary reconstruction with zygomaticus and standard implants. Few studies have evaluated quality of life after maxillary reconstruction. A single quality-of-life study has been performed to evaluate the outcome of maxillary reconstruction with a maxillary prosthetic obturator. More recently, Rogers et al evaluated quality of life in patients requiring maxillectomy for oncologic reasons. These authors compared maxillary reconstruction with a microvascular...
free flap to reconstruction with a maxillary obturator without implants. To explore the broad concepts of health-related quality of life and subjective outcome, the authors used 8 quality-of-life questionnaires, including the Denture Satisfaction and Obturator Functioning Scale. The authors found that there was no difference in quality of life between the patients reconstructed with a free flap to those reconstructed with a prosthetic obturator. It is important to note that within this quality-of-life study 10 of 18 patients who were reconstructed with a free flap were unable to wear a denture. We have shown that zygomaticus and standard endosseous implants offer a reliable method to retain, support, and stabilize a maxillary obturator after maxillary resection. We have found that patients reconstructed with this method

<table>
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<th>Patient</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Time From Resection to Reconstruction</th>
<th>Radiation Therapy</th>
<th>Prosthetic Reconstruction</th>
<th>Years Functioning With Prosthesis</th>
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</table>

are able to wear a maxillary obturator, have highly favorable speech and aesthetics, and are able to drink and eat without nasal leakage. However, patients will most likely have to bear the financial burden associated with this method of implant reconstruction. Given the complex nature of the ablative maxillary defect after extensive maxillary resection, this method of maxillary reconstruction is acceptable for this challenging patient population.

References

9. Taylor TD, Worthington P: Osseointegrated implant rehabilitation of the previously irradiated mandible: Results of a limited trial at 5 to 7 years. J Prosthet Dent 69:60, 1993