A Protocol for Maxillary Reconstruction Following Oncology Resection Using Zygomatic Implants

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The purpose of this clinical report is to present a surgical and prosthodontic reconstructive protocol for 20 patients who underwent maxillary resection following malignancy to the head and neck region. This protocol was developed over a period of 7 years while treating a series of 20 maxillary resections due to oncology. Patients were reconstructed prosthodontically using fixed-removable overdentures or fixed prostheses, with and without separate obturators. The treatment protocol includes a comprehensive diagnostic phase, resection surgery with immediate implant placement and temporary obturation, post resection evaluation, and prosthodontic rehabilitation. Treatment periods ranged from 6 to 96 months and success was evaluated using strict clinical, radiologic, esthetic, and functional criteria. Postsurgical radiology was undertaken at 6 monthly intervals. Almost all maxillary defects resulting from anatomic disruption of the maxillofacial complex can be well rehabilitated functionally and esthetically using this protocol in conjunction with standard implantology and fixed/fixed–removable prosthodontic principles. This protocol simplifies the rehabilitation and management of these defects by reducing surgical intervention, hosptilization, postoperative morbidity and treatment time, and prosthodontic procedural complications. *Int J Prosthodont 2007;20:521–531.*

Tumor ablative surgery and trauma to the midfacial and maxillary complex involves structures integral to phonetics, deglutition, and mastication, which makes reconstruction both difficult and controversial. The psychologic benefit of an esthetically pleasing reconstruction should not be taken for granted. The surgery is complex and involves sealing of the oral cavity from the nasal cavity, reestablishment of the paranasal sinuses, and restoration of the facial contour.[1] Dental rehabilitation is also a massive functional and esthetic consideration that should be considered when planning the proposed reconstruction.[2]

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Several methods have been proposed for postsurgical reconstruction.[3] The type of reconstruction depends on the extent of the resultant bony and soft tissue defect. Effective obturation requires a working relationship between the surgical and prosthetic teams. The prosthetic design has evolved over decades,[4] and the advent of osseointegration has revolutionized facial reconstruction in these cases. This technology can mostly circumvent the need for vascularized osseomyocutaneous grafts or these grafts in combination with nonvascularized free bone grafts. The advantage of endosseous implant rehabilitation over vascularized free flaps is the ability of the surgeon to inspect the resection cavity for recurrent disease. However visual inspection for recurrences in today's world is trumped by interval radiographic assessment using computerized tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). These investigations are costly and often unavailable to patients with recurrent disease, especially in a compromised health care system. Thus, this makes maxillary rehabilitation with endosseous implants a more viable and inexpensive treatment modality compared to first-world health care systems where these facilities and funding are readily available. In addition, the placement of endosseous implants facilitates prosthodontic

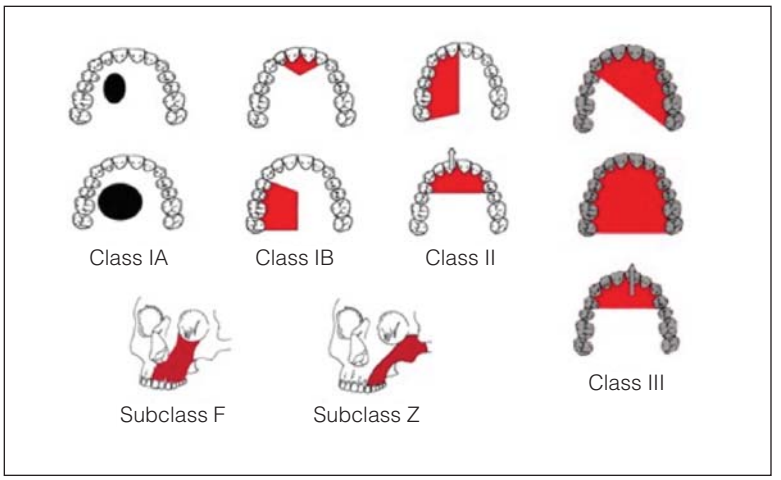


Fig 1 Classification according to Okay et al.[2]

rehabilitation, which allows for secure, esthetic, and functional replacement of ablated hard and soft tissues. Endosseous implant placement minimizes the disadvantages of silicone bulbs, obturators, and dentures.

The advent of the zygomaticus implant protocol has drastically enhanced treatment and in so doing has potentially revolutionized maxillary reconstruction following limited ablative tumor resection or trauma. This paper offers a protocol for surgical and prosthetic reconstruction, optimizing a cost-effective and predictable treatment outcome. This protocol minimizes surgical reconstructive intervention and prosthetic complications.

Classification of Maxillary Defects

The classification of maxillary defects has been based largely on pathology and surgical boundaries. Oncologically orientated classifications have been proposed by Ohngren,[5] Earley,[6] and Sakai et al.[7] Surgically based reconstructive classifications have been proposed by Davison,[8] Cordeiro and Joseph,[9] and Spiro et al.[10] Prosthetic based maxillectomy reconstructive systems have been proposed by Aramany.[11]

Very few systems include the surgical and prosthodontic aspects. Two useful published methods of classification include Brown's surgical classification[12] and a prosthetic classification by Okay[2] (Fig 1). The authors of the present paper believe there are shortcomings in these classifications, since they give no indication on morbidity and optimizing of the surgical-prosthodontic interface.

Okay's classification[2] is based on the functional anatomy available for surgical reconstruction after tumor resection. The classification allows for surgical defect evaluation by the prosthodontist, thus determining the future prosthetic rehabilitation of the patient.

Brown advocates that small maxillary defects can usually be restored with local flaps with or without free bone grafts,[3] while larger maxillary defects post-resection have traditionally required more advanced reconstruction with either vascularized soft tissue flaps combined with free bone grafts or vascularized osseomyocutaneous flaps.

Many microvascular osseocutaneous flaps have been attempted, including iliac crest with internal oblique muscle,[3] scapula,[13] radial forearm, or fibula free flaps. Pedicled flaps such as temporalis muscle flaps can also be used in conjunction with free iliac crest grafts; however, these have proven to be unpredictable, especially with increased size of the defect.[14] These authors also concluded that temporal osseomuscular flaps are unsuitable for maxillary reconstruction. Okay et al[2] recommend an algorithm for palatomaxillary reconstruction (Fig 2).

There is still a great deal of controversy regarding primary reconstruction of maxillectomy defects.[3] Maxillectomy defects reconstructed with a vascularized iliac crest bone graft with internal oblique muscle pedicled from the deep circumflex iliac artery can have up to a 38% mortality rate[3] following grafting, mainly due to recurrent disease. This is because once the patient has been grafted and the oral cavity is sealed off from the resection cavity, it is extremely difficult to detect recurrent disease. The current authors prefer implant-borne obturators for Class I, II, and III defects (see Fig 2), which allow for continual and comprehensive inspection and, if necessary, biopsy and extension of the surgical site.

The limiting factor regarding implant-borne dental rehabilitation is the volume of bone contained within many of these vascularized osseocutaneous grafts. In osseomyocutaneous flaps transferred from the iliac crest, scapula, or fibula, there is an inherent poor repli-

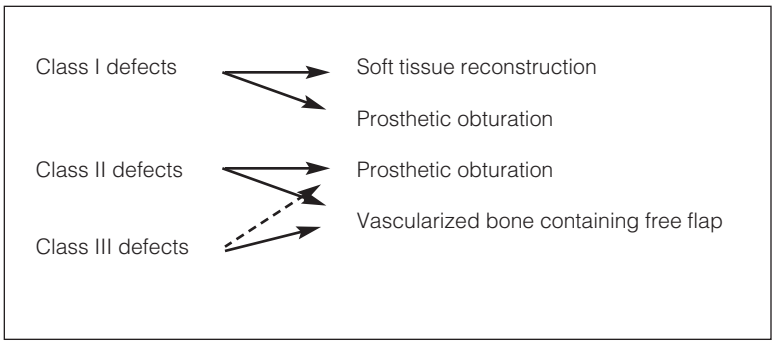


Fig 2 Algorithm for palatomaxillary reconstruction[2] modified to recommend implant-supported prosthetic obturation for Class III defects.

cation of normal maxillary anatomy, and this results in a lack of ridge form, sulcus depth, and appropriate oral soft tissue for implant rehabilitation. Prosthetic reconstruction is thus often seriously compromised by the placement of these grafts and in order to rehabilitate the patient with a fixed prosthesis, implant placement in these grafts is invariably inevitable. In many instances, the grafted tissue is of inappropriate type, quality, and/or quantity to function as denture-bearing mucosa. This is particularly true in the event of partial or total graft failure.

In plastic and reconstructive surgical training, obturation of maxillary defects is often achieved with vascularized free tissue transfer and local pedicled flaps, which do not contain an osseous component. Vascularized free tissue transfer originates from the radial forearm, while pedicled flaps include temporalis, sternocleidomastoid, and pectoral flaps. These soft tissue flaps unfortunately only obturate the defect and limit prosthetic reconstruction due to the poor retention and stability offered by this tissue. Patients are often left with speech and functional defects.

Reconstruction Protocol

Patients who require resection for oncology are subjected to a standardized preoperative radiologic survey. This includes routine orthopantomogram, occipitomental views (0, 15, and 25 degrees), a lateral cephalogram taken in occlusion, and CT scans in axial and coronal planes with a 3-dimensional spiral reconstruction (Fig 3).

Phase 1: Diagnosis

Surgical diagnosis. Incisional biopsy of the tumor is performed to obtain a definitive histologic diagnosis and grade of the tumor. This establishes the surgical and postoperative chemotherapeutic or radiotherapy protocols.

Prosthodontic preparation. Diagnostic casts are modified according to the expected resection, and a surgical obturator is prepared. This obturator should carry teeth on a clear denture base, which allows for easier evaluation of tissue pressure at the time of placement. It is duplicated in clear acrylic for jaw relation purposes. Two special trays are preprepared: one to fit the dentate and edentulous areas and the other to fit over the duplicate obturator.

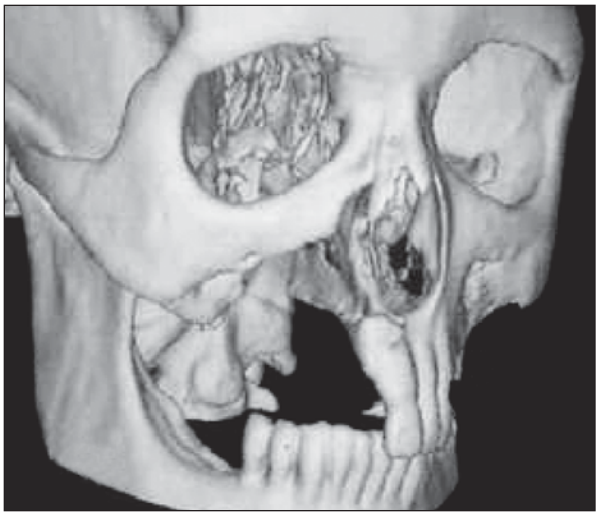


Fig 3 CAT scan postoncology resection.

Stereolithographic simulated surgery. Where possible, a stereolithographic acrylic cast is fabricated from the Dicom Format CT scanning data. The planned resection surgery is simulated on this cast, optimal implant positions are planned and prepared, and fixture lengths are measured. This allows for appropriate prescription of implant components and conformation of prosthetic design (Figs 4 to 6).

Phase 2: Tumor Resection, Immediate Implant Placement, and Obturation

Initial airway management is achieved most often by placement of a tracheostomy tube. Extraoral access to the tumor is achieved in most cases using a modified Weber-Ferguson flap with a wide soft tissue resection

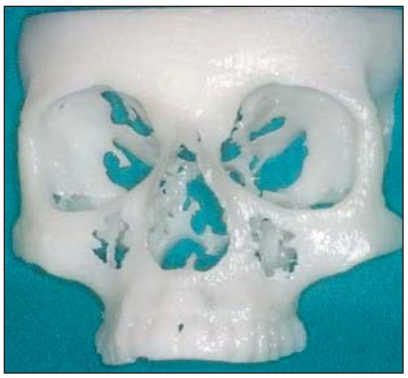


Fig 4 Stereolithographic model.

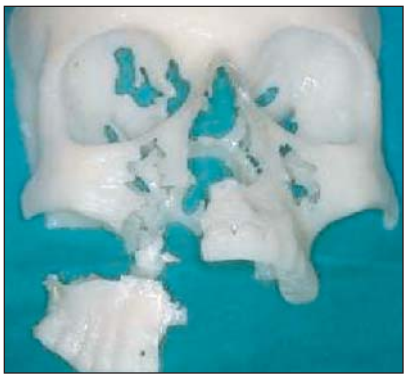


Fig 5 Simulated surgery.

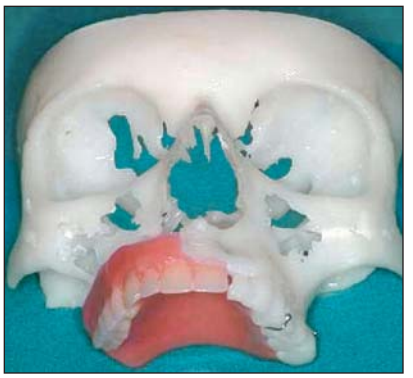


Fig 6 Confirmation of obturator design.

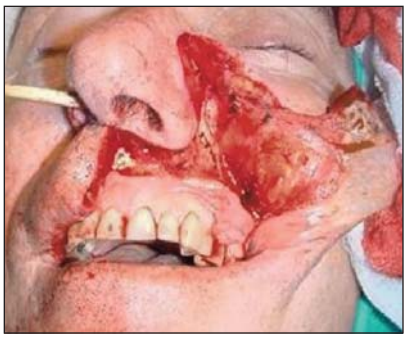
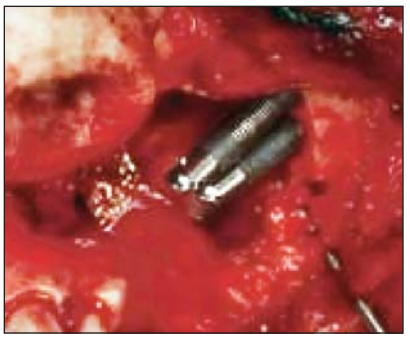
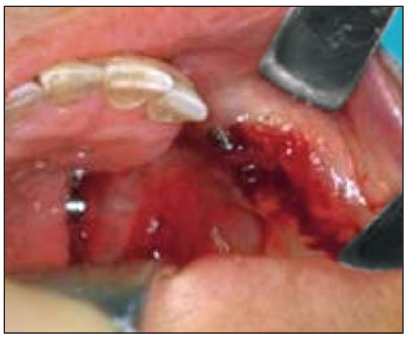


Fig 7 Weber-Ferguson incision.





Figs 8 and 9 Position and angulation of zygomaticus implants within the zygomatic stump projected toward the occlusal plane using the palatal height as a guide.

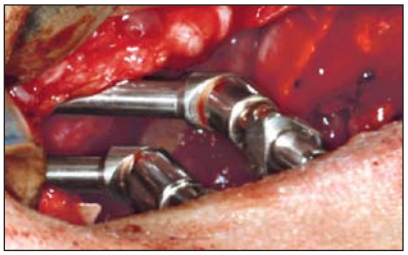


Fig 10 Oncology zygomatic implant in situ.

Fig 11 Oncology zygomatic implant.

margin and hemi-maxillectomy (Fig 7). A coronoidectomy on the tumor side of the mandible is carried out to reduce trismus and prevent postoperative displacement of the temporary obturator as the mandible opens and the coronoid process moves forward and downward. Once the tumor has been completely resected, frozen sections of the resection margin are taken to ensure that the patient is free of residual tumor. This is important because it enables the reconstructive team to place the implants at this stage.

Implant placement. The objective of implant placement is to reduce the postoperative morbidity with regard to speech, deglutition, and mastication with the use of a stable, immediately loaded implant surgical obturator. In addition, the placement is planned to recreate the buttresses and processes of the maxilla, allowing for appropriate force distribution of the prosthetic rehabilitation with the remaining facial skeleton.

Zygomatic implants (or a modified zygomatic "oncology" implant) allow for the lowering of the restorative platform to at least the level of the palate (Figs 8 and 9). The implant design also makes it easier to establish a common path of insertion of the prosthesis due to the angulated heads (45 or 55 degrees).[15] Most commonly, the 45-degree implant is used since there is no restriction by the sinus or alveolus.

The zygoma implant was modified for insertion into the resection stump, with the soft tissue portion of the implant being a smooth machined surface (Southern Implants) (Figs 10 and 11).[15]

A low nasal antrostomy is performed at the floor of the intact sinus, thus allowing for drainage of the maxillary sinus inferiorly as well as through the osteum.[16] When the resection margin has traversed across the midline of the palate and the entire nasal floor has been removed with the resection, zygomatic implants can be placed transnasally into the remaining contralateral maxilla (see Figs 24 and 25). It is well documented that osseointegration is achieved 6 to 8 weeks after implant placement.[17]

The 8-week healing period allows for sufficient stable bone healing and implant integration prior to commencement of radiotherapy if required.[18] These zygomatic oncology implants and adjunctive standard implants are placed carefully to achieve high initial mechanical stability and torque values to allow for early loading and thereby stable retention of obturator appliances. This greatly enhances immediate postoperative quality of life and allows for implant-supported obturation.

Impressions. The implant impression copings are luted together using a wide-bore canula cut and shaped around the implants and cured into position with light-cured acrylic resin (Triad Gel, Dentsply). A primary segmental-type impression is made over implant-level impression copings using addition-cured silicone putty. Care must be taken to establish the paths of withdrawal of the segments of the impression with or without the luted impression copings, avoiding large hard and soft tissue surgical undercuts of the remaining palate, sinus, nasal, and orbital contents.

The different segments of the impression are separated with K-Y (petroleum) jelly (Johnson & Johnson), numbered and marked with directional orientation using a Codman marker (Johnson & Johnson). The duplicate obturator is then used to establish horizontal and vertical jaw relation over the silicone impression of the defect in situ and before removal. Should some teeth remain, the second special tray is used to register an alginate impression over the duplicate obturator after the jaw relation record. The first special tray created over the defect allows for a second cast of the defect only, which is used for verification of prosthetic design. All the segments are carefully withdrawn piece by piece, allowing for accurate reassembly of the impression. These procedures allow for the creation of 2 casts: one of the defect and remaining teeth only and another including the defect and jaw relation in a single procedure. In addition, the duplicate obturator establishes the 3-dimensional position of the ablated tissues for the technician, allowing for the correct position of superstructure fabrication and particularly for sufficient space for ball attachments relative to the missing tissue and opposing dentition.

Surgical obturation. The surgical obturator is modified intraoperatively after implant placement to restore normal soft tissue facial contour over the resection site and guide soft tissue healing. A peripheral seal is established with tissue conditioner (GC Soft Liner) to minimize air and fluid escape during the postoperative period, thus optimizing oral function. This obturator is secured by 215-mm transosseous titanium screws in the remaining palate and supported by the zygomatic implants on the affected side.

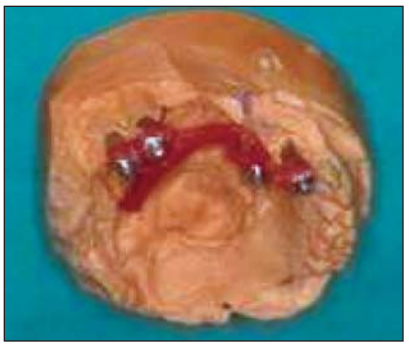
Soft tissue closure. The Weber-Ferguson flap is closed with a 2-layered technique, and a nasogastric feeding tube is placed in the contralateral nostril.

Interoperative care. Postoperative antimicrobial therapy is administered intravenously for 5 days postsurgery together with appropriate analgesics as required. Standardized tracheostomy care is carried out to ensure a patent tracheal stoma in the postoperative period. Nasogastric feeding is commenced immediately after initial resection surgery and continued until the interim obturator is placed to prevent macromotion on the immediately placed implants. Postoperative facial physiotherapy is performed on a regular basis to relieve postoperative trismus and maintain mouth opening.

Phase 3: Clinical and Laboratory Prosthetic Planning

Pouring of the impressions is complicated by the use of angulated implants, because the laboratory analogues represent the restorative interface on a straight analogue. The technician must take great care to ensure sufficient plaster encases the analogue to maintain stability in the cast as well as represent the extent of the surgical defect in the master cast.

After pouring of the primary plaster casts, the position of resected teeth and alveoli are reestablished using the boundaries of the stereolithographic model and the duplicate obturator. The superstructure and retentive elements are planned considering paths of insertion and replacement of lost prosthetic volume. Implant abutments are also planned, if necessary, using screw-retained angular correction abutments to establish a common path of insertion of the superstructure. The superstructure may need to be fabricated in sections to facilitate placement along different paths of insertion. Abutments are placed on the plaster cast and the appropriate impression copings placed and splinted using a self-curing acrylic (Duralay, Reliance Dental Manufacturing) (Fig 12). Special trays are fabricated over the splint, if necessary, using a split-tray technique. A duplicate surgical obturator is modified to fit over the Duralay splint for jaw relation purposes (Fig 13).



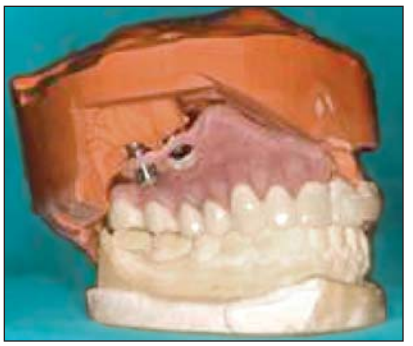


Fig 12 Impression copings with Duralay splint.

Fig 13 Duplicate of the surgical obturator over the Duralay splint ready for a new jaw relation record.

Fig 14 Duralay splint.

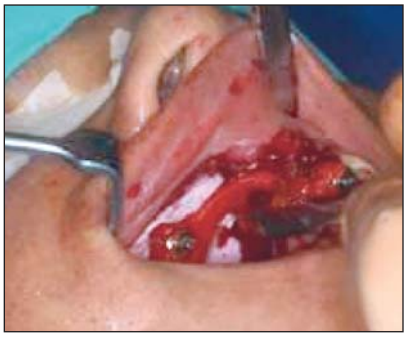


Fig 15 Splint in situ with impression material blocking out undercuts.

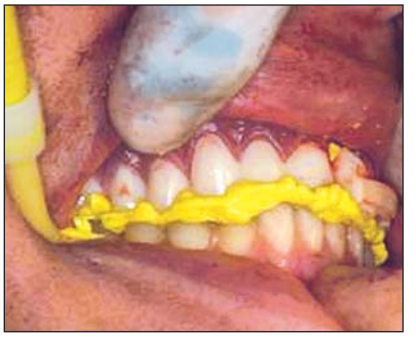


Fig 16 Jaw registration.

Phase 4: Wound Evaluation and Definitive Impression

After approximately 1 week, allowing for laboratory time, a second general anesthetic is administered to evaluate and/or debride the resection site, as well as achieve an accurate 3-dimensional secondary impression of implant positions. The preplanned abutments are placed at the appropriate orientation and torque value. All undercuts and the defect are filled with sectional addition-cured vinyl polysiloxane putty (President, Coltene Whaledent) to the level of the fixture heads, creating a clear path of placement and withdrawal of the secondary impression. The splinted impression copings are placed and, if necessary, sectioned and re-luted using light-cured acrylic (Triad Gel, Dentsply) (Figs 14 and 15).

The duplicate surgical obturator is then placed over the splint and the jaw relation is established (Fig 16). The special tray is then used for the definitive impression of implant position and defect margins after removal of the jaw relation. It is important to accurately establish soft palate and resection margins. This is easier with tracheostomy operations. If nasogastric tubes are used, care must be taken to compensate for soft palate deviation. The primary obturator is then further relined if necessary and replaced.

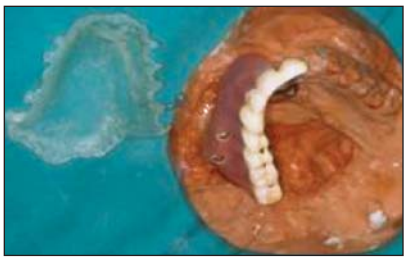
Phase 5: Laboratory Fabrication of Definitive Superstructure and Interim Obturator

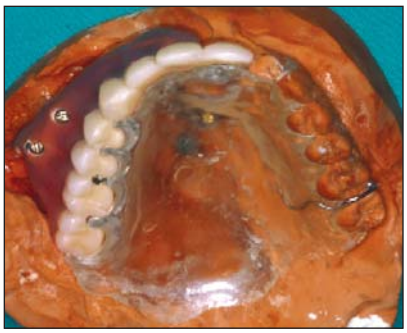
The secondary master casts are poured and mounted on an articulator using the jaw relation in the modified duplicate surgical obturator. This obturator also indicates the prosthetic volume in which the superstructure and retentive elements are placed. The superstructure and interim obturator are then fabricated (Figs 17 and 18). It is important that the laboratory fabricate a duplicate cast of the superstructure and retentive elements for future prosthetic maintenance. This will allow for prosthetic maintenance procedures to be carried out without the need for complicated sectional impression techniques.

This fixed superstructure is fabricated on passive abutments (Southern Implants) to assist with the passive fitting of the superstructure, thus allowing for the inevitable dimensional changes inherent in impressions, plaster casts, and laboratory castings. Early previous cases were routinely restored with an overdenture protocol (Figs 19 and 20), while more recent cases have been restored with fixed dentoalveolar elements and a separate removable implant-supported obturator (Figs 21 to 23).

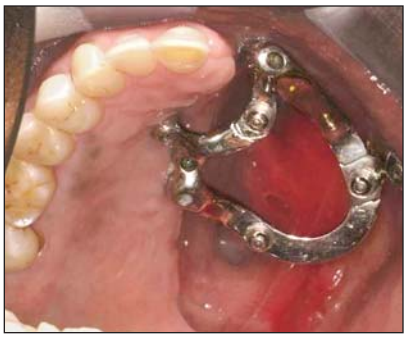
This has vastly improved the esthetics and patient confidence, and has also simplified postoperative man-

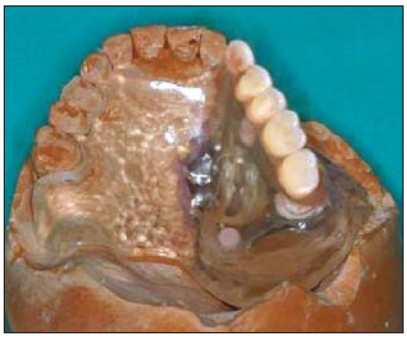
Figs 17 and 18 Fixed prosthesis on the cast with interim obturator.





Figs 19 and 20 Definitive splinted superstructure with interim obturator on the cast.





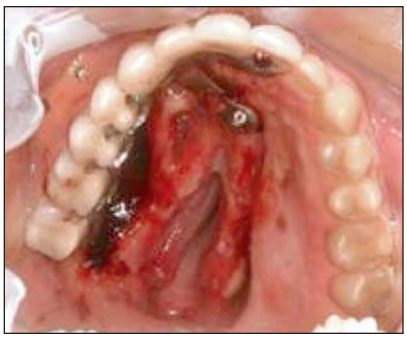


Fig 21 Fixed prosthesis in situ.

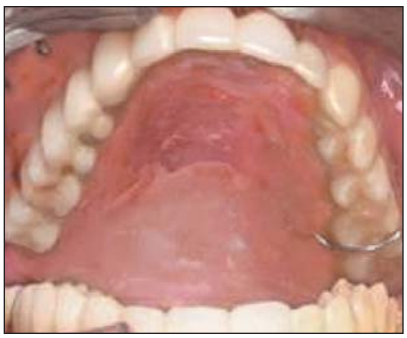


Fig 22 Fixed prosthesis with obturator.

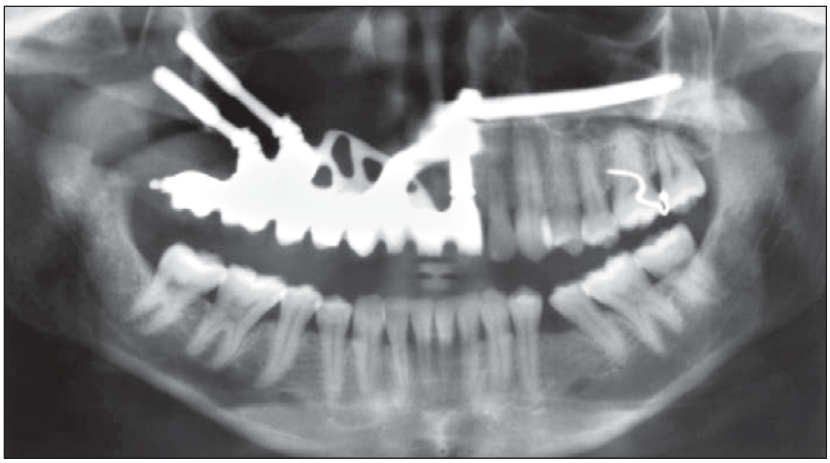
Fig 23 Interim obturator.

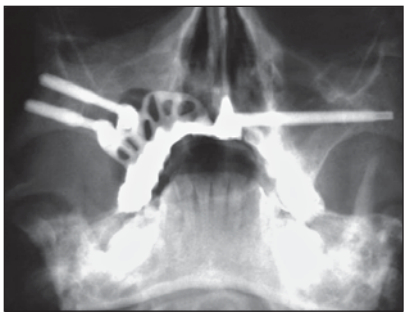
agement because occlusal complications are reduced and the prosthodontist can concentrate on a secure peripheral seal. The fixed dentoalveolar unit should be limited to the distal implant without cantilevers, since this allows for better access to the defect margins for maintenance of speech and leakage.

Trismus is a common complication of hemimaxillectomy surgery, which is further exacerbated by postoperative radiotherapy. The authors' experience has shown that the overdenture type prosthesis has a far greater vertical volume, which has sometimes proved to be difficult to manipulate in and out of the mouth. The 2-part design depicted here is preferred (Figs 21 to 23), because it uses a smaller obturator that overcomes this problem and still effectively obturates the maxillectomy defect along the milled interface with the fixed component containing the teeth and replaced maxillary component.

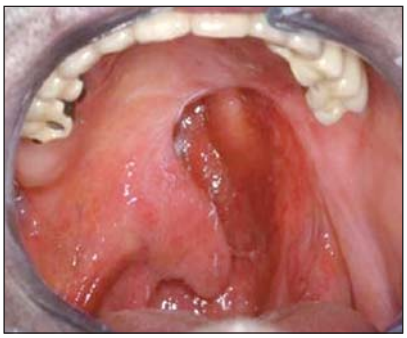
Phase 6: Wound Inspection and Placement of Definitive Superstructure and Interim Obturator

The final general anesthetic is given 2 weeks later (to allow for laboratory procedures) (3 weeks postresection) to inspect and/or debride the resection site and place the definitive cast titanium superstructure (Figs 19 to 20). The interim obturator margins are inspected and adjusted and relined if necessary (Fig 23). Postoperative radiographs are taken to confirm the position of the implants within the bone and ensure that the prosthesis is firmly secured to the implants (Figs 24 and 25).





Figs 24 and 25 Radiographs of the implants.



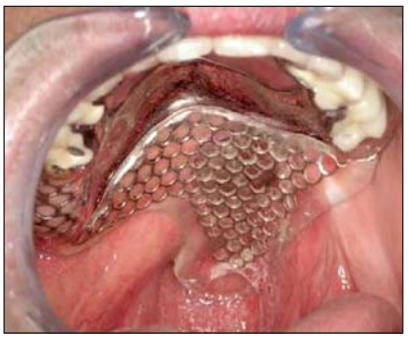


Fig 26 Final implant-supported prosthesis with soft palate defect.

Fig 27 Milled-edge obturator in soft palate defect.

Phase 7: Definitive Obturation

During the next 6 weeks after interim obturation, patients return for prosthetic maintenance. This includes monitoring of speech and deglutition, adequate peripheral seals, and home-care maintenance regimens of the superstructure, prosthesis, and defect. After stabilization of oral functions, the definitive obturator is fabricated using the relined obturator as a guide (Figs 26 and 27). Intranasal endoscopy has proved useful in diagnosing the areas of leakage past the obturator during speech, mastication, and swallowing. Should radiation or chemotherapy be indicated, they should be undertaken at this stage, and the definitive obturation postponed until the tissues have stabilized.

Phase 8: Maintenance

The surgical site is monitored closely by both the oncologist and reconstructive teams for adequate postoperative healing and long-term recurrence. Prosthetic maintenance is extensive and ongoing, particularly in the first year, where soft tissue changes can be extensive. The obturators may require continual peripheral adjustment with soft tissue conditioner and/or acrylic on a regular basis (2 to 4 weeks) or on patient demand. Comprehensive oral hygiene training is undertaken using brushing techniques and pulsating irrigation at least twice per day (Waterpik or Oral-B Oxyjet). It is possible to use 50-mL syringes with plastic connecting tubes[19] for financially impaired patients or those without access to electricity. It is recommended that the patient attend psychotherapy, including trauma counseling, to help them adapt and manage the quality of life changes. The reestablishment of facial esthetics and function as close to normal assists patients with physical and psychologic acceptance.

Protocol Evaluation

These protocols were established during the treatment and reconstruction of 20 patients treated over a period of 8 years. All 20 patients underwent maxillary resection for oncology (Table 1).

The patients were treated from 1997 to 2006. Eighteen of the patients were rehabilitated with a fixed-removable prosthesis and 2 with a fixed prostheses. The age of the patients ranged from 12 to 82 years (mean: 56 years) (14 male, 6 female). The longest loading period was 8 years. A total of 106 implants were placed (Table 2). All patients in this series were reconstructed with a combination of zygomatic and standard implants and either a fixed or fixed-removable prosthesis.

Table 1 Patient Distribution

Twenty oncology resections
11 squamous cell carcinoma (M = 6/F = 5)
1 mucoepidermoid carcinoma (F = 1)
1 ameloblastoma (M = 1)
1 chondrosarcoma (M = 1)
1 basal cell carcinoma (F = 1)
2 adenoid cystic carcinoma (M = 1/F = 1)
1 infection (actinomycosis) (F = 1)
1 odontogenic keratocyst (M = 1)
1 osteoblastic chondrosarcoma (M = 1)

Table 2 No. of Implants Placed by Type and Loading Period

Loading period (mo)	Zygomatic implants		Conventional implants		Total	
	Implants	Patients	Implants	Patients	Implants	Patients
0–12	15	6	19	6	34	6
13–36	8	4	10	3	18	4
37–60	10	5	29	7	39	7
61–96	7	2	8	3	15	3
Total	40	20	66	19	106	20

Table 3 Complications Recorded by No. of Visits

Complication	Visits	% of complications
Speech	17	38.6
Nose leakage	5	11.4
Food leakage	4	9.1
Screw loosening	4	9.1
Prosthesis mobility	3	6.8
Prosthesis fracture	3	6.8
Trismus	3	6.8
Pain	2	4.5
Screw fracture	1	2.3
Paraesthesia	1	2.3
Contracture	1	2.3

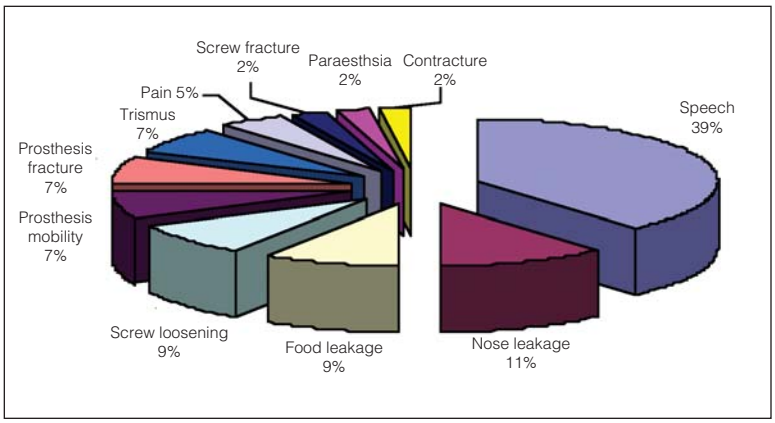


Fig 28 Restorative complications.

Implant Survival

A total of 3 implants were lost in 1 patient. Three extraoral surface-enhanced titanium implants placed in the outer table of the frontal sinus were lost in 1 oncology patient. This patient underwent previous radiotherapy in excess of 3 years prior to surgery. It is unclear if the implant site was included in the radiation field, because the radiation records and mask were unobtainable. No hyperbaric oxygen protocols were used. There has been no loss of either the zygomatic implants or those implants that were placed into the remaining zygoma stump after resection. This represents a 96% conventional implant success and 100% zygomatic implant success using these protocols.

Restorative Results and Complications

Despite the loss of 3 standard implants, all initially placed superstructures were retained. One superstructure was sectioned to accommodate fixture loss. Additional appointments for the management of complications were recorded. Forty-four such postoperative prosthetic "complication" visits were recorded (Table 3 and Fig 28). The majority of these complaints were to manage air, fluid, and food escape around the prosthesis during speech and mastication (59.1%).

Patient Mortality

Three of the 20 oncology patients (15%) died due to recurrent malignant disease during the first 5 years after surgical excision (2 patients with squamous cell carcinoma and 1 pediatric mucoepidermoid carcinoma). All 3 patients had positive neck nodes and underwent subsequent radiation after surgery. One patient died due to a pulmonary embolus at home after discharge.

Radiation

Five patients underwent postresection radiation. These patients exhibited positive margins close to the resection margin and all underwent neck dissection.

Discussion

The zygomatic implant—first introduced by Brånemark[20] in 1989—revolutionized the treatment of many maxillectomy defects. In combination with standard and zygoma implants, these implants have become the treatment of choice in these cases. Reconstruction is performed at the time of primary resection surgery, thus excluding the need for bone grafting and/or soft tissue transfer. Larger defects involving the orbital floor or zygoma (Class 3 and 4 defects) often still require the complex flaps as mentioned above, although the authors have achieved full rehabilitation in some of cases using only implant-supported obturation (see Fig 2).

Due to the complex nature of the defect following maxillectomy, reconstruction is fraught with controversy, particularly if the excision involves an extraoral or extensive soft palate extension. Even if the surgical reconstruction of the maxilla with vascularized bone and soft tissue is successful, the patient still requires implant placement in order to wear a denture. This further delays rehabilitation. Many patients who undergo immediate surgical reconstruction and then need postoperative radiotherapy miss the important 6-week start of radiotherapy because of the complications of healing and the morbidity associated with vascularized flaps.

Composite free tissue transfer has an established role in head and neck oncology for the reconstruction of the bony defect following tumor ablation. Many papers have been written about quality of life assessments on patients following surgery and reconstruction.[21] The patient's potential psychologic well-being depends on the use of the simplest method of reestablishing a functional and esthetically acceptable reconstruction. A quality of life assessment was not done in this series of patients. A further publication is planned to compare the accepted quality of life assessments associated with tissue transfer reconstructions.

The development of the zygomaticus implant as well as the huge evolutions in the understanding of osseointegration in standard implantology have allowed development of a protocol for the reconstruction of large maxillary defects after tumour ablation, trauma, and gunshot wounds, which leave similar bony ablation defects. The advantages include:

1. The ability to provide a fixed prosthetic appliance without the need for complex grafts.
2. This technique provides a predictable and reproducible protocol for maxillary reconstruction. This reconstructive protocol uses zygomatic implants, which have a proven success rate of greater than 97%.[20] Only 44 prosthetic visits were undertaken to manage the complications for 20 patients. The authors believe this to be a very low complication rate. For maxillectomy patients, health-related quality of life (HRQoL) in patients with obturator reconstructions has been compared with those who have had a free flap reconstruction.[22] No significant difference in HRQoL scores was seen between the 2 groups. In terms of obturator reconstructions specifically, social adjustment reportedly increased with increased obturator satisfaction, whereas extent of resection was the most significant predictor of obturator function, with smaller resections having greater function.[23]
3. Donor site morbidity, eg, gait disturbance and herniation of abdominal contents (iliac crest), loss of normal hand function (radial forearm), and inability to rotate the shoulder (scapular) is avoided.
4. This method of reconstruction circumvents the need for a vascularized flap, which reduces the postoperative morbidity associated with a lengthy anesthetic. This also reduces hospital time associated with these procedures. Patients undergoing microvascular free flap reconstruction have been associated with a significantly increased length of stay. A length of stay greater than 16 days is associated with significantly lower chewing, swallowing, and cumulative University of Washington Quality of Life Scale scores.[24]
5. Once the patient has been grafted and the oral cavity has been sealed off from the resection cavity, it is extremely difficult to detect recurrent disease.[3] The authors prefer implant-supported obturators for Class I, II, and III defects, which allow for continual and comprehensive inspection and biopsy and extension of the surgical site if necessary.
6. Irradiated tissues have documented impaired bone healing,[18] thereby often excluding patients from implant-assisted prosthetic reconstruction. This protocol allows for endosseous implant integation prior to commencement of postoperative radiotherapy. The authors recommend implant placement at the time of initial resection surgery, irrespective of disease staging.

Prior to the introduction of osseointegration and the advent of implant-supported prostheses, maxillary defects were obturated with removable prostheses. The reconstructive success and quality of life experienced by these patients was dictated by the extent of the defect and the support provided by the remaining dentition. These implant-supported prostheses are immeasurably more stable and avoid the complications associated with biomechanics and decay associated with the remaining dentition, particularly with radiation and osteoradionecrosis.

It would clearly be ideal if fixed prostheses could be anatomically achieved for all patients, particularly in the rare closed resective defects. This papers has presented a working protocol for these complex cases, especially when microvascular reconstruction is unavailable or considered inappropriate. It remains clear that the most appropriate reconstruction will require individual consideration for each case.

With all surgical procedures, complications do arise, which may include sinus infections, oroantral fistulae, facial pain, and implant failure. The success rate of implants into grafted bone is approximately 76% to 84%,[25] whereas Brånemark recorded a 97% success rate for the zygomaticus implant.[20]

Conclusions

The protocols presented here for the treatment of maxillary defects after tumor ablation can be integrated into the armamentarium for the rehabilitation of the maxilla and facial region. This provides the patient with an opportunity to undergo primary reconstruction in a more cost-effective manner while still optimizing function and eesthetics, thus allowing for regular and effective maintenance.

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