Prosthetic Rehabilitation of Defects of the Head and Neck

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ABSTRACT

Patients afflicted with head and neck cancer, traumatic injuries to the head and neck, or those with congenital or developmental defects benefit from multidisciplinary team management. The head and neck region participates in complex physiologic processes that can often be impeded by these circumstances. Evaluation of the patient by the maxillofacial prosthodontist can assist the other members of the team in providing treatment planning options for the patients. Intraoral defects arising from these circumstances can be treated with prosthodontics that serve to assist with speech, swallowing, and to some degree mastication. If chemotherapeutic or radiation modalities are also used to treat the head and neck, assessment of the patient by the maxillofacial prosthodontist may prove to identify factors that may predispose to undesirable sequelae. Preventive treatment by elective tooth extraction, prosthodontic assessment, and patient education prove to assist in predictable management of these oftentimes complex presenting conditions. Facial defects arising from similar circumstances can be an alternative or adjunct to plastic surgical reconstruction and offer the added advantage of tumor surveillance in susceptible patients.

KEYWORDS: Maxillofacial prosthetics, maxillofacial prosthodontist, tumor ablative surgery

Patients treated for head and neck tumors often require interdisciplinary collaboration between many clinical areas to arrive at more effective comprehensive management. Presurgical planning facilitates a more concerted effort between the various surgical disciplines of radiation oncology, medical oncology, and speech therapy so that surgical eradication of disease and post-surgical functional outcome emerge favorably.

Maxillofacial prosthetics is that area of dentistry dedicated to prosthetic correction and management of maxillofacial defects acquired from tumor ablative surgery, trauma, congenital defects, or alterations of growth and development. The practitioners that practice this subspecialized form of care are relatively few in number

and may belong to one of a few prosthodontic organizations:

- American Academy of Maxillofacial Prosthetics (<http://www.maxillofacialprosth.org>)
- International Society for Maxillofacial Rehabilitation (<http://www.ismr-org.com/>).

This population of patients requires special needs for treatment and follow-up, and coordination and communication between the surgical specialties is needed. When such cases are planned prior to surgery, the maxillofacial prosthodontist should be consulted to

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provide input regarding a patient's capacity for functional rehabilitation.

PROSTHODONTIC CONSULTATION

Patients presenting for evaluation of head and neck should have a comprehensive assessment of their presenting condition to arrive at a specific diagnosis. Often, this will be inclusive of a thorough examination, which may be accompanied by radiologic imaging, diagnostic tests, and other diagnostic records.

Assessment of Oral Health

Patients referred for evaluation are given a complete oral examination that documents all soft tissues, bone, and teeth. In addition, mandibular opening is documented because this is vital to maintain oral health and nutrition. Sudden decreases in mandibular opening may be pathognomic of recurrent disease. It is important that the patient be assessed for caries and periodontal disease as these precipitate a higher incidence of osteoradionecrosis of the jaw.^{1,2} Teeth with a questionable prognosis should be considered for extraction at least 14 days prior to the initiation of radiation to the underlying bony structures as this will also increase the likelihood of osteoradionecrotic lesions.³⁻⁵ Upon extraction, it is imperative to consider alveoloplasty and primary mucoperiosteal flap closure to expedite healing. This is especially true in areas where the alveolus has been expanded to permit delivery of divergent root tips. Areas of thin friable mucosa overlying bony prominences such as tori or exostoses can also be a nidus for development of chronic wound-healing problems. If head and neck radiation is anticipated, it may be appropriate to consider making a custom radiation stent to immobilize the mandible and adjacent structures for repeatable positioning during treatment. Further, due to the effects of ionizing radiation on salivary quality and quantity, it is suggested to provide patients with a method of treating their teeth with daily fluoride.⁶⁻⁸ This is usually in the form of custom fluoride trays to apply prescription fluoride gel to reduce the incidence of radiation-induced caries.

Assessment of Speech and Swallowing

Swallowing has been documented to be a highly complex physiologic process that is divided into three major phases: oral, pharyngeal, and esophageal.⁹ The oral phase begins with a lip seal and is followed by the oral preparatory subphase, which includes that of mastication. To properly accomplish this, competent tongue movement is essential to manipulate the bolus of food and allow comminution to take place. Once the palatoglossal arch is contacted by the bolus, the involuntary phase of swallowing is initiated as the pharyngeal phase. As

resection of some tumors often affects these areas, it is imperative that swallowing be evaluated presurgically and postsurgically. This can be done with a modified barium swallow and also gives some indication as to the disability or efficiency of the swallow.¹⁰ Information from these studies is often helpful for patients undergoing resection of the maxilla, tongue, and soft palate. Prostheses can often be redesigned to promote more efficient swallowing based on this information.

Strategic Determination of Prosthetic or Surgical Rehabilitation

Resection of the head and neck for tumor ablation creates a dilemma in consideration of reconstructing the area with either tissue or a prosthesis. The advantage of using autogenous tissue creates the likelihood of effectively closing the area with sensate tissue compatible with the surrounding structures. The advent of microvascular grafting has allowed additional tissue to provide a reproduced anatomic base that discourages additional scarring and promotes similar physiology. Alloplastic material can also be considered in these situations, although cost considerations may preclude their use. The alternative use of prostheses may be beneficial as well if tumor surveillance is desired to prevent recurrent advancement of disease. Use of osteomyocutaneous flap reconstruction was introduced in reconstruction of mandibular discontinuity defects.¹¹ If discontinuity of the mandible is anticipated with tumor ablative surgery, infection, osteonecrosis, or in some cases where advanced mandibular resorption results in pathologic fracture, flap reconstruction affords an excellent treatment option. With some tumor ablative surgery of the tongue involving composite mandibular resection, it is important to understand that having a competent tongue is essential for bolus manipulation as reconstruction of a discontinuous mandible will not improve this situation.

There are algorithms associated with reconstruction of the maxilla when infrastructural maxillectomy is performed.¹²⁻¹⁴ In general, the larger the maxillary defect, the greater the indication for this type of reconstruction. As opposed to mandibular reconstruction, osteomyocutaneous flap reconstruction of the maxillectomy cavity can obscure surveillance and may make rehabilitation more problematic by obstructing drainage in the remnants of ipsilateral paranasal sinuses, immobilizing the upper lip, tethering the free end of the soft palate, and restricting mandibular mobility.

DIAGNOSIS AND TREATMENT PLANNING

Dysphagia, or difficulty in swallowing, can be attributed to altered anatomic or neuropathic sources. Further, it can result from tumor ablative surgery, radiation therapy to the head and neck, or demyelination disease processes.

As mentioned earlier, it is essential that this presenting symptom be diagnosed and considered in the final treatment planning stage. In some patients manifesting dysphagia, it may be of concern providing an augmentive oral appliance, which may prove to enhance deglutition in the oral cavity. In some patients with an incompetent swallowing reflex, an augmentive appliance may exacerbate the propensity to aspirate, complicating management further.

Xerostomia, the lack of salivary quantity, can often present after radiation therapy to the head and neck or be associated with chemotherapy, age-related changes, or Sjögren's disease. The sequelae associated with xerostomia predispose the dentition to caries and periodontal disease to some degree. If unattended, this can further lead to osteomyelitis, predisposition to osteoradionecrosis, and other forms of localized infectious

processes. Prevention of dental caries in these patients is best afforded with regular dental evaluation, use of custom fluoride carriers, and elective tooth removal of questionable teeth prior to the start of radiation therapy.

Mucositis, the inflammation of oral mucous membranes, is sometimes seen in patients treated for head and neck cancer. Mucositis is the most common side effect seen with radiation therapy to the head and neck and can also be seen with chemotherapy. Its management is often palliative, with care taken to avoid superinfection. Use of a coating agent such as Carafate (Axcen Pharma, Birmingham, AL) has been suggested to discourage colonization of the denuded oral mucosa.

Osteoradionecrosis of the jaw has been documented to be associated with radiation therapy to the head and neck. Other factors that exacerbate osteoradionecrosis have been identified.¹⁵ The incidence of

Figure 1 (A) CT scan showing benign fibro-osseous lesion of maxilla. (B) Outline of resective area preserving dentition. (C) Defect created after removal of tumor. (D) Surgical obturator placed with packing material and ligated to place. (Courtesy Eric J. Moore, M.D.)

osteoradionecrosis is variable, depending on the source, and has decreased with modern methods of planning and radiation therapy to the head and neck.¹⁶ Nevertheless, it can be a debilitating situation occasionally requiring microvascular reconstruction to restore mandibular continuity.

Bisphosphonate-associated osteonecrosis of the jaws is also a debilitating disease process. It can result from use of oral medications used to treat bone density deficiency but more often results from intravenous forms of the medication.¹⁷ When significant exposure of bone and destruction is evident, treatment with hyperbaric oxygen has proved ineffective, and it is best treated with alloplastic or autogenous reconstruction.

RESTORATION OF INTRAORAL DEFECTS

Maxillary tumors are often treated with resection to control the progression of disease. This procedure often involves the hard palate and, if extensive, may involve the infraorbital rim and the contents of the orbit as well. Classically, this operation has been used for tumor control and has been followed by using a removable

prosthesis called an obturator. Although the primary objective is tumor control, the more hard palate present, the more stable the prosthesis becomes in swallowing, speech, and mastication. A series of these prostheses are often fabricated for patients undergoing maxillectomy due to the changing nature of defects during the early perioperative period and that after radiotherapy if indicated (Fig. 1). The quality of life improvement for these patients is measurable and has been documented in studies. Either attached to teeth, osseointegrated implants, or an edentulous jaw, the prosthesis is integral to a patient's function with regard to speech and swallowing (Fig. 2).

Mandibular resections have been used to treat benign and malignant disease of the floor of mouth, tongue, or the mandible itself. Traditional resection can involve excision of tumor tissue while preserving ~10 mm superior/inferior mandible height to maintain mandibular continuity. More extensive resection may involve an en bloc resection of the mandible, creating a discontinuity between the temporomandibular joint, ramus, and body. Although classically closed with adjacent tissue to include tongue and remaining soft

Figure 2 (A) Defect created from infrastructure maxillectomy. (B) Interim obturator prosthesis used for resection of maxilla. (C) Interim prosthesis in place showing fitting to adjacent dentition. Prosthesis improves speech and swallowing.

Figure 3 (A) Three-dimensional model created from CT scan showing the osteomyelitic defect of left mandibular parasymphysis. (B) Osseointegrated implant placement in fibular osteomyocutaneous flap to reconstruct mandibular defect. (C) Prosthesis reconstruction of mandibular discontinuity defect. (D) Panoramic radiograph of patient after reconstruction. (Courtesy Christopher F. Viozzi, D.D.S., M.D.)

tissues, this creates significant disability with speech, swallowing, mastication, and facial symmetry. As previously described, reconstruction with osteomyocutaneous flaps has afforded significant improvement of function, assuming a competent and neurologically intact tongue. The secondary use of osseointegrated implants in the flap adds a further dimension to reconstruct the masticatory potential of these patients (Fig. 3).

Soft palate resections for tumor control create a unique dimension of consideration, as this is a dynamically important area for speech and swallowing. Treatment by removal of a portion of the soft palate often creates a limitation in the range of motion of the soft palate for velopharyngeal closure. This important phys-

iology may also be affected neurophysiologically by bulbar paralysis or demyelination disease processes.¹⁸ Of course, cleft palate patients benefit from having this area either reconstructed or treated with a prosthesis to aid in speech and swallowing.¹⁹ Prosthetic reconstruction can exist in the form of a speech appliance that is anchored to the remaining dentition, which also extends into the defect by an obturator extension into the pharyngeal area to assist with the defect either created or preexistent (Fig. 4).

Tongue resections are often treated aggressively for tumor control as they have a propensity to locally metastasize to the neck. As the tongue is so important in swallowing and speech,^{20,21} its absence creates a

Figure 4 (A) Adult unrepaired isolated cleft palate. (B) Prosthesis used to restore patient.

Figure 5 (A) Implant-retained auricular prosthesis. (B) Bar attachment supported by three osseointegrated implants. (C) Obverse and (D) reverse of prosthesis containing clips in acrylic resin substructure.

Figure 6 (A) Orbital defect created by lacrimal gland carcinoma. (B) Orbital prosthesis secured in place with medical-grade adhesive.

Figure 7 (A) Patient treated for maxillary sinus carcinoma resulting in defect of right maxilla and exenterated orbit. (B) Magnetic buttons attached to obturator prosthesis. (C) Extraoral view of obturator buttons. (D) Two-component orbital prosthesis made of silicone and acrylic resin. (E) Final prosthesis in place and margin concealment with eyeglasses. (F) Dimension of ocular prosthesis used in prosthesis also helps determine spatial constraints of orbital defect.

deficiency that can be compensated by prosthetic augmentation of the palate. This prosthesis lowers the vault of the hard palate to afford contact with either remnants of the tongue or a reconstructed floor of mouth to aid in propelling a food bolus or with articulation of some consonants.²² Use of this prosthesis has been shown to decrease oral transit times for patients with glossectomy.

RESTORATION OF EXTRAORAL DEFECTS

Auricular defects can be congenitally associated with Treacher-Collins syndrome or other second arch variants that result in microtia. Traumatic avulsion or tumor removal can create an auricular defect that can be treated with plastic surgical reconstruction or an epithesis. Indications for treatment with a prosthesis will be based on the extent of the defect, as larger areas become difficult to reconstruct surgically. If a prosthesis is indicated, preservation of the tragus may help to conceal the anterior margin of the prosthesis. Retention of the prosthesis can be accomplished with medical-grade adhesive or is more predictable with use of osseointegrated implants, which have a high degree of success in temporal bone²³ (Fig. 5). If a healing deficit accompanies microtia, use of a bone-anchored hearing aid affords an improvement by bone conduction. Implants can often be placed into just two to three locations that correspond with the 1, 3, and 5 o'clock positions of the left ear and 7, 9, and 11 o'clock positions of the right ear.

Orbital defects are best reconstructed with obliteration with a microvascular flap or can also be treated with a prosthesis. If it has been decided to use a prosthesis, sufficient space for the restoration should exist prior to referral for prosthesis fabrication. Determination of this space often starts with evaluation preoperatively by use of a standard-size ocular prosthesis. Occasionally, removal of the eyelids, extraocular muscles, and other soft tissues will be needed prior to constructing the prosthesis (Fig. 6). If there is communication with a conjoining oral defect, joining to the oral prosthesis with magnetic retention of the approximating surfaces can result in mutual support, further stabilizing the prosthesis (Fig. 7). Attention should also be paid to preserving the position of the eyebrow symmetrically. Osseointegrated implants can also be used in the frontal bone, although long-term survival has been cited to be problematic.^{24,25}

Nasal defects can be reconstructed with regional flaps taken from the forehead or adjacent tissues. Skin texturing and color differences from sun-exposed skin may preclude this from being aesthetically pleasing. In these cases, use of a prosthesis may be best to restore symmetry and aid in blending skin tones to be inconspicuous (Fig. 8). Consideration should be given to retention of these prostheses, as air exchange through this area is filled with significant moisture, often precluding the effective use of adhesives. Resection of the nasal bones should be accomplished paying attention to avoid distortion of the contour and position of the cheek,

Figure 8 (A) Defect resulting from resection of basal cell carcinoma. (B) Partial reconstruction of defect with split-thickness skin graft. (C) Prosthetic reconstruction of nasal defect.

Figure 9 (A, B) Large facial combination defect of orbit, nose, cheek, and upper lip restored with silicone facial prosthesis.

lip, and nasal labial folds. Raw surfaces (lip portion of the wound) should be lined with a skin graft avoiding primary closure. The anterior part of the nasal septum should also be removed to gain access to the defect. Some consideration of using osseointegrated implants should be given in these circumstances to avoid the problems inherent with use of adhesives here. Implants in these areas are placed in the floor of nose (maxilla) or glabella.

Facial prostheses in general can be made to obliterate defects of the cheek, nose, or forehead areas. Key factors in planning these cases include avoiding margin placement over movable tissue, using engageable undercuts, and using skin grafts to make reciprocating surfaces to stabilize the prosthesis (Fig. 9).

SURVEILLANCE

One of the biggest advantages in using removable prostheses in the head and neck cancer patient is the ability to provide tumor surveillance. As the overall survival of head and neck cancer approaches 52%, there is a window of time to monitor for local recurrent lesions. With use of prostheses, it becomes possible to directly visualize recurrent areas that may be apparent in the perioperative period to the third year of follow-up

Figure 10 Recurrent lesion found on nasal septum 3 months after maxillectomy. Such lesions are found through surveillance and regular follow-up after resective surgery.

(Fig. 10). If these areas are reconstructed with tissue, the ability to provide surveillance is markedly reduced.

Maxillofacial prosthetics is a subspecialty dedicated to offering a treatment option for patients afflicted with a defect of the head and neck or those with defects of congenital origin. Interdisciplinary coordination of treatment of head and neck defects starts with comprehensive consultation from all members of the team. After all members have made a complete assessment, the patient's best interest is considered along with the benefit to risk ratio. Shared decision-making is important so that the patient understands which treatment path is chosen.

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