Chapter 33 – Segmental Mandibulectomy

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Segmental mandibulectomy describes removal of a segment of mandible and thereby interrupting its continuity. Segmental mandibulectomy may be performed in the setting of a *composite resection*, that is, resection of a segment of mandible in continuity with a cancer of the oral cavity or oropharynx or a primary cancer of the alveolar ridge. Excision of bone, as commonly performed today, was reported by Slaughter and colleagues and then Ward and Robben half a century ago,[1,2] and the fundamental concepts of extirpation have not changed in the interval. An exception is that uninvolved mandible is no longer removed to provide adequate exposure to remove the cancer. Unless the bone is involved, an osteotomy is now carried out by retraction of the bone fragments, which provides adequate exposure to remove the cancer without removing the bone.

What *has* changed significantly in the half-century interval are the techniques of reconstruction, selection of which is the most problematic decision-making dilemma facing the operating surgeon. Resection of the alveolar ridge with maintenance of continuity of the mandible is termed *marginal mandibulectomy* (Table 33-1) and is discussed in Chapter 32. Segmental mandibulectomy should be performed for cancers that actually invade the bone without soft tissue involvement, in which case reconstruction is less problematic. Segmental resection of the mandible is also performed in patients with advanced osteoradionecrosis (ORN) that cannot be treated medically.

Postoperative radiotherapy is required for most patients because of their advanced stage at initial evaluation. Patients with bone involvement are staged T4, and many patents will also have clinical evidence of cervical adenopathy. Recent reports suggest that concurrent adjuvant chemoradiation therapy is beneficial in this high-risk group.[3,4] Surgical extirpation should be performed with the intention of complete excision of the cancer, as well as expeditious healing to avoid untoward delays in initiating adjuvant treatment.

The use of primary or adjunctive radiation therapy has become a standard of treatment in the management of advanced cancer of the head and neck. Unfortunately, one of the devastating complications resulting from this therapy is mandibular ORN. Its incidence ranges between 2% and 25% and it varies in severity. Mandibular ORN has proved to be a difficult condition to manage. The use of conservative treatments such as antibiotics, local débridement, and hyperbaric oxygen therapy has been advocated for lower grades of ORN, as well as for early ORN. For advanced ORN, segmental resection of the mandible along with reconstruction with vascularized bone-containing free flaps harvested from the fibula, iliac crest, and scapula is emerging as a mainstay of therapy for ORN. Militsakh and associates[5] described the role of an osseocutaneous radial forearm free flap in the treatment of mandibular ORN. The authors reported excellent postoperative outcomes when ORN was managed with an osseocutaneous radial forearm free flap, even in the setting of heavily irradiated tissue.

Table 33-1 -- DEFINITIONS OF MANDIBULECTOMY

Mandibulotomy	Osteotomy of the mandible to permit exposure, no bone resected; bone is reapproximated at the completion of the procedure
Marginal mandibulectomy	A portion of the mandible, typically the alveolus or lingual plate, is resected while leaving the continuity of the mandible intact
Segmental mandibulectomy	A portion of mandible is resected, with disruption of condyle-to-condyle continuity Ramus Angle Body Parasymphysis

PATIENT SELECTION

Cancer arising in the oral cavity and oropharynx may invade the mandible. Bone invasion is usually associated with a large cancer arising on the floor of the mouth, on the alveolar ridge, or in the retromolar trigone region (Fig. 33-1). If the cancer is adjacent to bone or fixed to the periosteum without invasion, marginal mandibulectomy is adequate to ensure a safe margin of resection (Fig. 33-2). If the bone is involved by cancer, marginal mandibulectomy is inappropriate for adequate tumor excision because of the high rate of recurrence associated with insufficient resection of bone. Histologic whole-organ studies have demonstrated that once cancer gains

access to marrow spaces, tumor cells can spread beyond the apparent gross margins and involve not only the marrow cavity but also the neurovascular bundle.[6] Gross tumor involvement by cancer results in bone resorption, as well as osteoblastic activity, and may cause pathologic fractures (Fig. 33-3). Marginal mandibulectomy, if performed in these situations, leads to a high rate of local recurrence.

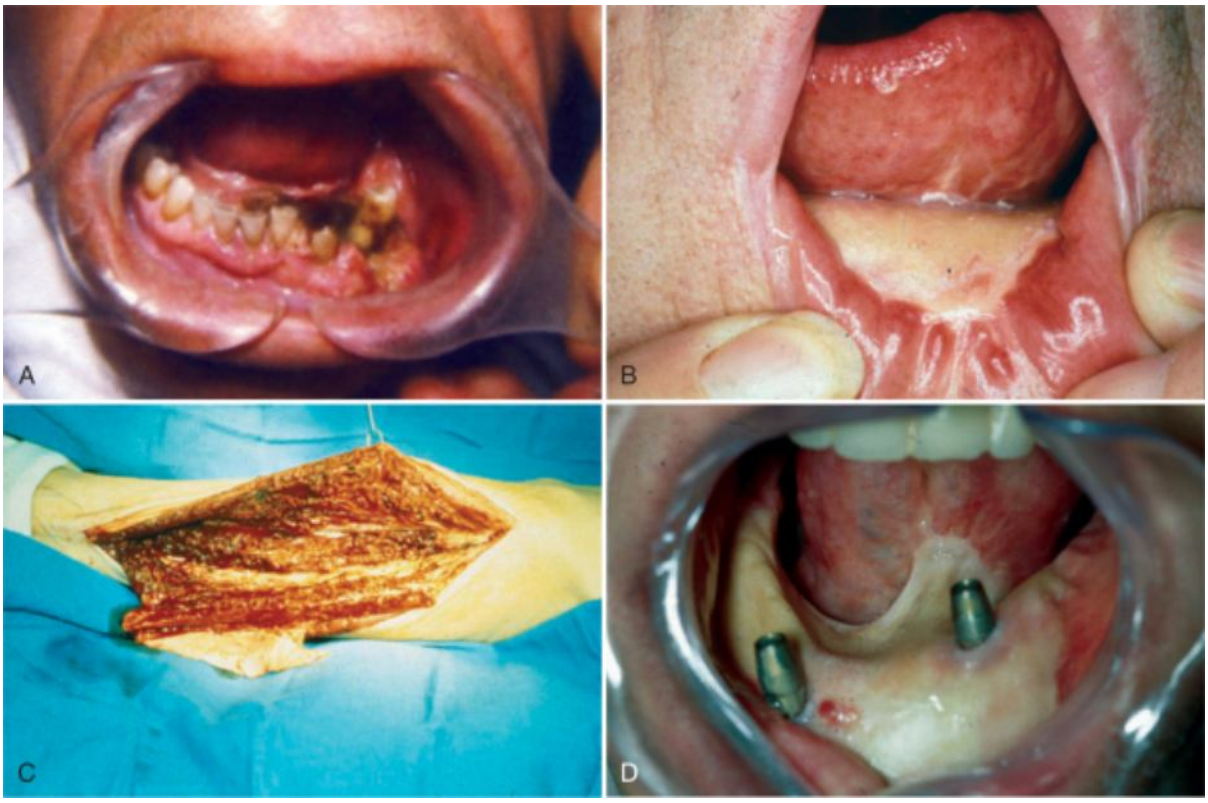

Figure 33-1 **A,** A squamous cell carcinoma arising from the alveolar ridge and invading the bone of the mandible. **B,** Patient after segmental resection and reconstruction with a fibular osseocutaneous free flap. **C,** Donor site for a fibular flap. **D,** Fibular flaps are wide enough to accommodate dental implants.

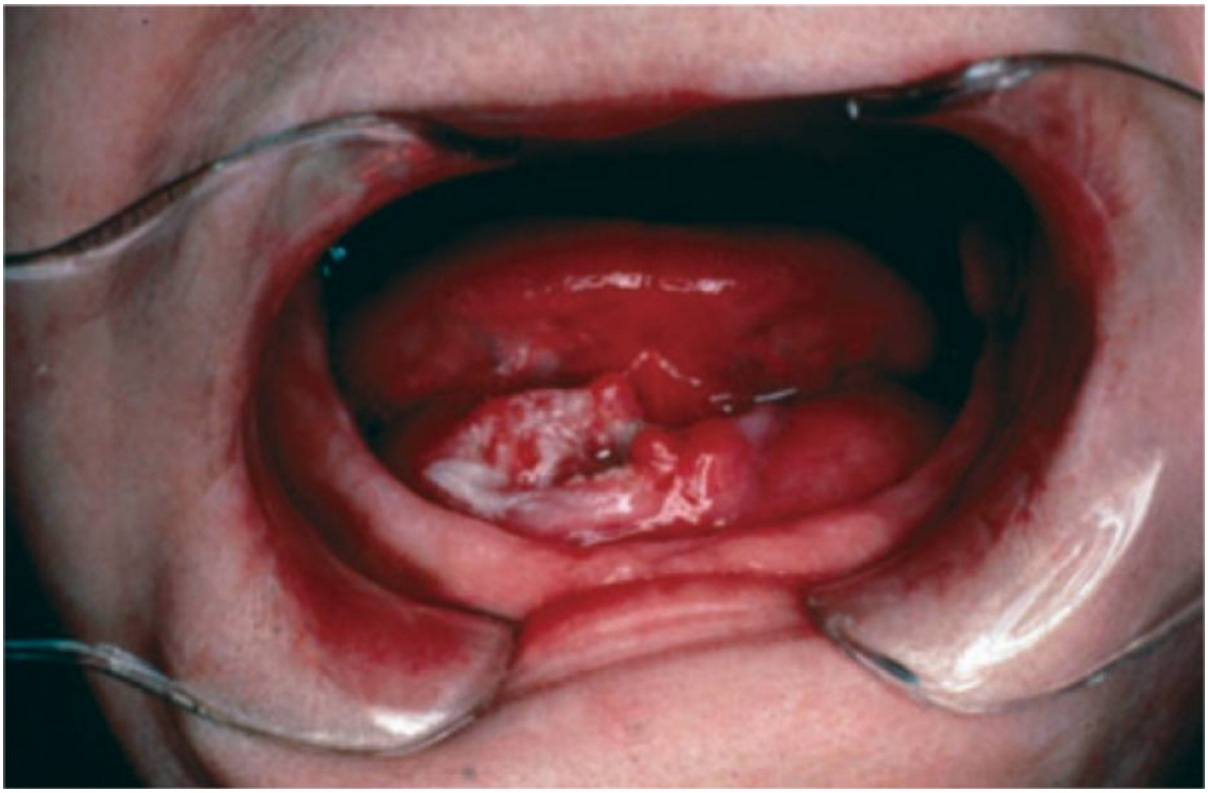

Figure 33-2 Squamous cell carcinoma of the anterior floor of the mouth adjacent to the mandibular alveolus. In these cases, uninvolved bone must be resected to ensure an adequate margin. This is an ideal situation for a marginal mandibulectomy rather than segmental mandibulectomy.

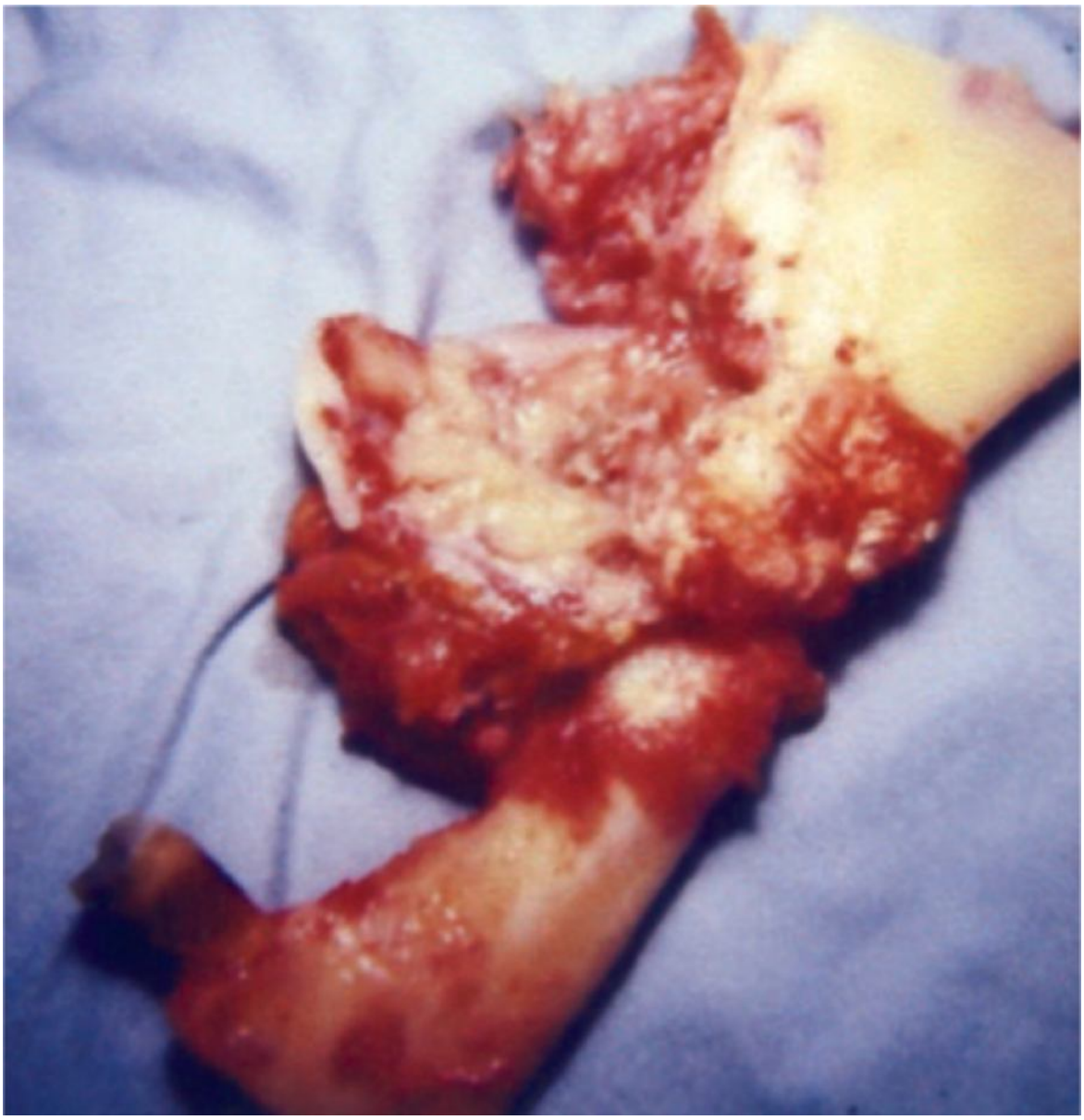

Figure 33-3 Pathologic fracture caused by invasion and partial destruction of the mandible by squamous cell carcinoma.

Preoperative determination of the presence or extent of involvement of the mandible can be challenging. Palpation of the tumor with determination of mobility of the tumor relative to the mandible is often more accurate than radiologic imaging. More than 60% to 70% of bone mineral must be lost before radiographic changes become evident (Fig. 33-4). Even axial computed tomography (CT) scans often cannot reliably demonstrate the presence or extent of tumor invasion into bone, although with extensive involvement the loss of bone is apparent (Fig. 33-5). This lack of reliability is even more troublesome in patients who have previously undergone treatment, either surgery or radiotherapy. A study by Tsue and associates suggested that findings on CT are confirmed histologically in only 73% of patients.[7] The use of a computer software program that permits cross-sectional imaging of the mandible may improve the sensitivity somewhat. However, correlation between radiographic evidence of bone involvement and histologic evidence of cancer involvement is, at this time, inadequate.

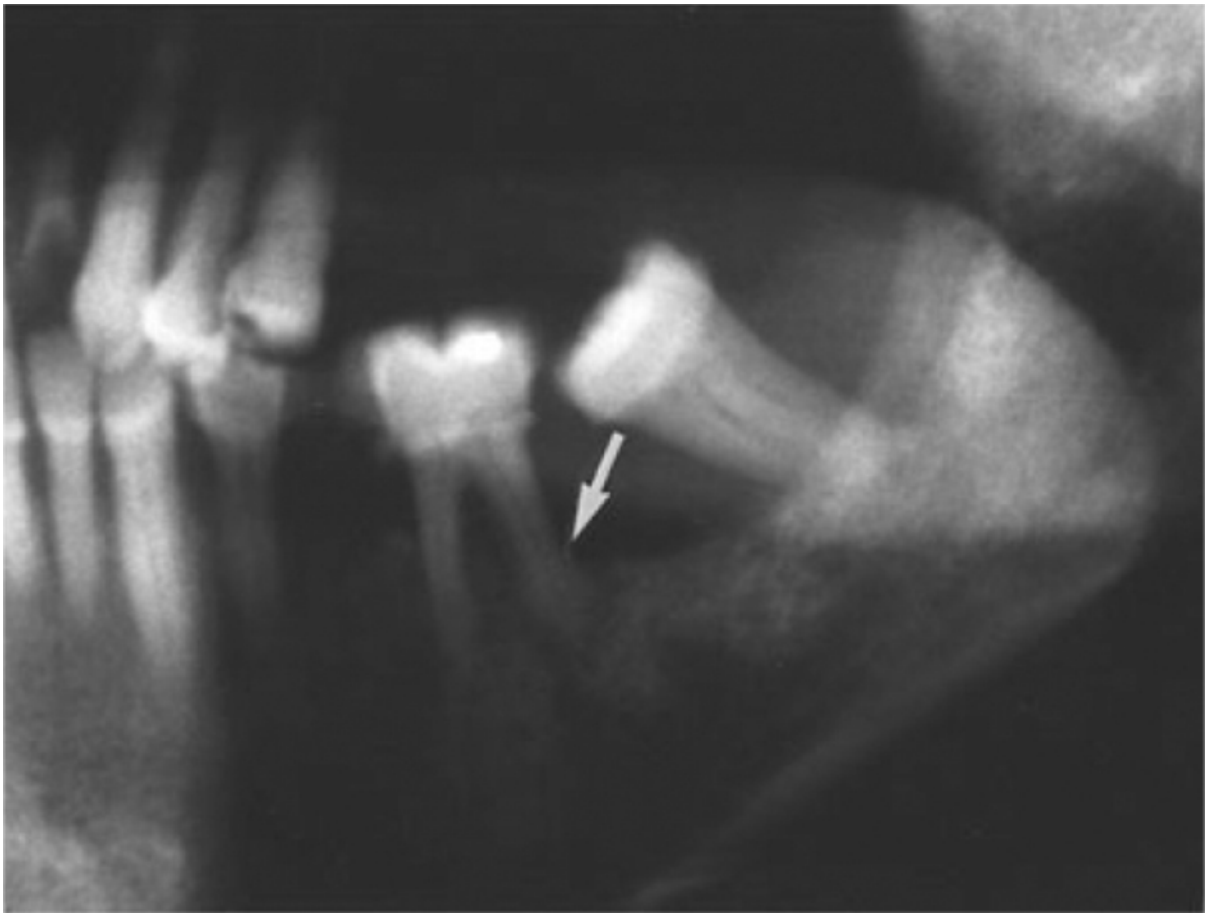

Figure 33-4 Panorex view of the mandible demonstrating bone erosion from carcinoma invading the mandibular alveolus *(arrow)* adjacent to the molar tooth.

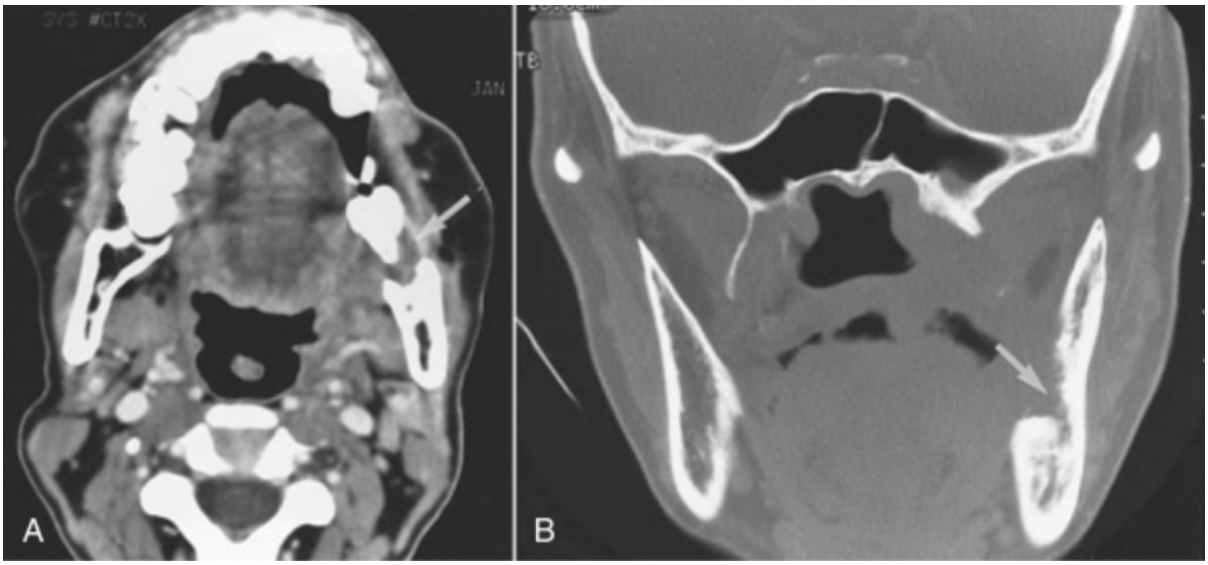

Figure 33-5 **A** and **B,** Computed tomography scans of a patient with retromolar squamous cell carcinoma that eroded the mandible and enveloped the molar tooth *(arrows).*

Imaging techniques such as technetium-99m bone scanning or positron emission tomography may provide some benefit in selected patients. Unfortunately, the local inflammatory response to the adjacent cancer and the poor resolution combine to reduce the clinical utility of these studies.

Magnetic resonance imaging (MRI) may help detect cancer involving the marrow spaces because it does not rely on changes in bone density.[8] MRI occasionally helps in preoperatively determining the extent of bone resection

required to assist in planning reconstructive techniques (Fig. 33-5). Unfortunately, a study has suggested that MRI may have an excessive rate of false-positive results.[9] McGregor and MacDonald demonstrated that bone involvement typically occurs through the alveolus rather than through either the lingual or buccal cortical plates in an edentulous mandible.[10] This axiom does not hold true in patients who have undergone radiation therapy, however. Decision making regarding mandibulectomy after previous treatment is problematic and relies heavily on physical examination and the surgeon's clinical judgment.[6,10]

The mainstay of patient selection remains physical examination, with careful attention to bimanual palpation of the mandible and estimation of the probability of involvement of the bone by cancer. Unfortunately, preoperative evaluation does not reliably correlate with histologic findings at the time of surgery: rates of false-positive and false-negative results approach 50%. Determination of adequate margins is difficult because of the complex three-dimensional anatomy of the resected specimen. Frozen section cannot be performed on bone biopsy samples, but it may be useful on samples taken from the neurovascular bundle or bone marrow.

In past years, excision of cancer in the posterior oral cavity usually included bone removal, even in the absence of definite involvement of bone with tumor. Mandibulectomy was performed routinely to facilitate exposure of the tumor and postoperative soft tissue closure. Alternative approaches such as mandibulotomy provide excellent exposure while retaining the continuity of the mandibular arch. This technique is recommended when the mandible is not involved directly by the cancer.

Selection of the proper location for osteotomies is sometimes problematic. Once bone involvement has been demonstrated either clinically or radiographically, the extent of invasion of cancer into bone is not easily determined. A marrow cavity that appears uninvolved on CT scan may be found on histologic evaluation to include cancer cells, hence the requirement for generous bone margins. The finding of cancer involvement in bone margins after decalcification is even more problematic and typically requires reoperation for tumor control because positive margins essentially guarantee recurrence and death.[11] Wide margins of at least 2 cm beyond the visible extent of bone involvement should be the rule. This is true not only for invasive squamous cell carcinoma but also for primary bone malignancies such as osteogenic sarcoma and chondrosarcoma, which present individual problems in management.

Reconstruction of the Mandible

The most difficult decision making regarding segmental resection of the mandible is that involving reconstruction of the mandible. These decisions must be made preoperatively to prepare for the reconstructive portion of the procedure. Loss of continuity of the mandible is associated with significant morbidity. As a U-shaped structure hinged only at the open ends to the skull base, the mandible is rotated and translated by coordinated muscular pull at various points and vectors. Interruption of continuity of the mandibular arch results in difficulty positioning the remaining mandible, as well as the obvious effects of loss of the framework for the soft tissue and teeth. With the advent of modern free tissue transfer, there have been great advances in mandibular reconstruction after resection for cancer. Nonetheless, substantial morbidity accompanies these reconstructive procedures, so the surgeon must decide not “what is best” but “what is best for *this* patient.”

Various techniques for mandibular reconstruction have evolved over the years[12,13] and are listed in Table 33-2. The techniques most commonly used today are free vascularized bone or a metal reconstruction plate covered by a free vascularized or pedicled soft tissue flap. The first technique provides optimal long-term results because even with adequate muscle coverage, metal plates still tend to become exposed.[13] Although reconstruction adds to the operative morbidity of the procedure, most patients, even in the older age group, appear to tolerate these long procedures quite well.

Table 33-2 -- METHODS OF RESTORATION OF MANDIBULAR CONTINUITY

Soft tissue only
Regional pedicle flap
Skin graft
Reconstruction plate
Plate and screw with a regional pedicle flap
Plate and bone-anchored post with a titanium hollow- screw reconstruction plate (THORP)
Microvascular free flaps with bone (preferred option)
Radius
Fibula

Scapula
Iliac crest

Defects after segmental resection of the mandible can be divided into lateral and anterior defects because their indications and morbidity vary accordingly. Controversy surrounds reconstruction of defects involving the mandible posterior to the mental foramen. Komisar[14] demonstrated that these patients do not benefit functionally from the reconstructive efforts that are required to reconstitute bone continuity. Urken and coworkers[15] noted that in their hands reconstruction is warranted not only to restore continuity of the mandibular arch but also to facilitate dental prosthetic rehabilitation with osseointegrated fixation devices placed in the vascularized bone. They also routinely reconstruct the inferior alveolar nerve to restore sensation in the lower lip. Lateral bone defects are not in and of themselves debilitating, but function is more likely to be impaired by the associated soft tissue loss (or tethering) and dental loss. Decisions regarding reconstruction should be based on the patient's age, dentition, and expectations, as well as on the anticipated soft tissue defect. Occasionally, a patient who is an exceptionally poor risk can be reconstructed with soft tissue only, such as a pectoralis major myocutaneous or split-thickness skin graft. If immediate reconstruction of these defects is elected, a free vascularized bone graft performed at the time of surgery is the optimal strategy.

There is no controversy regarding reconstruction of mandibular defects anterior to the mental foramen. Mandibular continuity in this central region is critical for maintenance of tongue protrusion, cosmetic reasons, including chin contour, and oral cavity competence. Loss of the anterior segment of bone results in severe deformity with associated loss of function of the oral cavity, including mastication, oral competence, drooling, and swallowing ability (Fig. 33-6). In addition, loss of anterior support for the tongue may result in airway difficulty for these patients. For these reasons, reconstruction of anterior mandibular defects is mandatory, particularly with the current widespread availability of surgeons skilled in microvascular reconstructive techniques. Reconstruction should be performed at the time of resection. The details of reconstruction are discussed in Section 9 of this text.

Figure 33-6 This severe deformity is due to resection of the anterolateral segment of the mandible with failed bone reconstruction. Pectoralis myofascial flaps were used to reconstruct the soft tissue defect.

Distraction Osteogenesis

A novel means of mandibular reconstruction via distraction osteogenesis as popularized by Ilizarov in long bones has been applied to hypoplastic mandibles.[16] It seems feasible that this technique may find utility in mandibular reconstruction. This technique involves dividing the bone and leaving the periosteum intact. As the two ends of the bone are slowly separated by an external apparatus fixed to both bone segments, new bone is deposited by the remaining periosteum. Its use in mandibular reconstruction has been demonstrated recently by several investigators.[17,18] It seems unlikely that this technique will replace free flap mandibular reconstruction, however, because of the time required to replace a mandibular segment with this technique.

PREOPERATIVE PLANNING

All patients must undergo tracheotomy because post-operative oral disability will result in aspiration. Edema may lead to airway obstruction. The tracheotomy should be performed at the beginning of the procedure to allow removal of the endotracheal tube from the oral cavity to facilitate excision of the cancer. Although a tracheostomy is routine in such cases, it may not be viewed as such by the patient and requires preoperative discussion. A discussion of the tracheostomy, feeding tubes, Foley catheter, and drains is mandatory during the preoperative counseling.

Complete dental evaluation and extractions when necessary are important in the management of oral cavity cancer. Postoperative radiotherapy or chemoradiotherapy is often required, and retention of teeth that are in poor condition will probably lead to substantial postoperative and postradiation morbidity. A large cancer of the oral cavity is most likely to be encountered in patients who have had less than adequate dental care. We believe that dental extractions should be the rule in this patient population and that only teeth that are in excellent condition and may play a role in dental rehabilitation should be saved. The teeth in the involved section of bone do not require removal preoperatively because they will be resected in continuity with the tumor.

Perioperative antibiotics are indicated and must be administered before the procedure begins. Antibiotics effective against oral flora, including anaerobes, must be selected. It is useful for surgeons to establish a routine so that they do not neglect to order these antibiotics and to ensure that they are given at the appropriate time. Failure to use antibiotics in clean-contaminated cases such as these will result in an unacceptable high rate of postoperative wound infection.

As previously noted, plans for reconstruction of the mandible must be finalized before the procedure. Preoperative vascular studies to define the donor vascular anatomy is routine in some centers, and preoperative discussion with the reconstructive team (particularly if from another department) is mandatory.

Communication with the operating room nursing staff is necessary to ensure that all are aware of the planned procedure. Appropriate instruments and powered tools should be available, including both saws and drills with appropriate blades and bits. Frequently, two teams are operating at the same time, so preoperative planning will reduce the disorder often found in such busy two-team rooms. Nevertheless, one surgeon must be designated as the primary surgeon, with all significant decisions being referred to that person. The site of the mandibulectomy, the donor site, and any planned neck dissection should be marked on the skin to prevent any possibility of “wrong-side” or “wrong-site” surgery.

The choice of incisions varies with the site of the cancer and the skill of the surgeon. Usually, mandibulectomy can be performed through an upper neck incision 2 to 4 cm below the mandible. It is usually incorporated into a half-H or similar incision because neck dissection is typically performed as part of the procedure (Fig. 33-7). A lip-splitting incision dramatically improves visualization during resection of the primary cancer and mandible and contributes little additional postoperative morbidity. Such an incision may not be required for mandibulectomy in some patients, however, if adequate mucosal incisions are made to facilitate degloving of the mandible (visor flap). Because the ipsilateral inferior alveolar nerve will be sacrificed, the contralateral mental nerve must be preserved. Unfortunately, preservation of the contralateral mental nerve often creates significant technical difficulties in exposure when a visor flap is used. Marking the proposed incision and then halting the neck incisions just inferior to the chin will permit extension into a lip-splitting incision should additional visualization be desired intraoperatively.

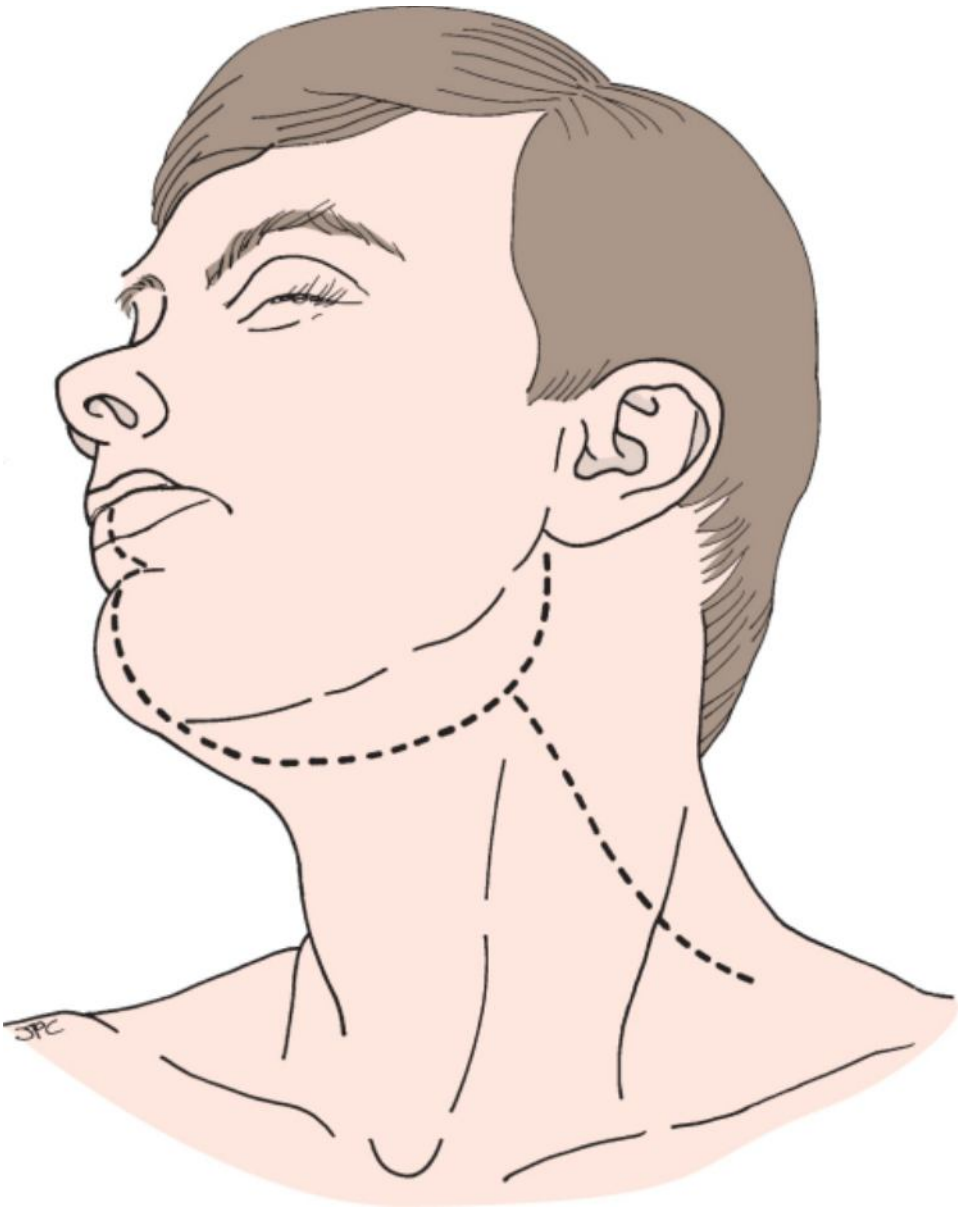

Figure 33-7 Among the incisions used for composite resection is the lip-splitting modified half-H. This incision provides excellent visibility of posterior oral cavity lesions. It can be used for bilateral neck dissection by the formation of a submental trifurcation.

Neck Dissection

Squamous cell carcinoma that is of sufficient size to warrant segmental mandibulectomy will require neck dissection. Patients with no palpable adenopathy on clinical examination (N0) and with negative preoperative imaging results should undergo selective neck dissection in levels I through III. Removal of level IV is necessary in patients with or without squamous cell carcinoma of the lateral tongue because such patients may have “skip lesions” in level IV without involvement of levels II and III. In the face of palpable adenopathy, either selective neck dissection for N1 and N2c or radical or modified neck dissection (with preservation of the spinal accessory nerve) for more advanced stage N2/N3 is advocated. For patients undergoing segmental mandibulectomy for cancer of other histologic types, neck dissection should be based on the biologic characteristics of the tumor.

Care must be taken during neck dissection to remove level I nodes adjacent to the facial artery (i.e., prevascular and postvascular nodes). The surgeon may be tempted to leave these nodes in situ to reduce the possibility of injury to the marginal mandibular nerve. Unfortunately, they may contain metastases from primary cancer involving the alveolus and mandible and hence must be removed. Neck dissection usually precedes mandibulectomy and excision of the cancer. The superior dissection is performed last, and the specimen can be left attached to the periosteum of the mandible.

Decisions regarding the contralateral neck may be difficult. In the presence of cancer-free nodes and a laterally located posterior oral cavity lesion, contralateral neck dissection may not be necessary. However, if the primary cancer has involved the base of the tongue, if the tumor approaches or crosses the midline, or if large nodes are

present in the ipsilateral neck, the likelihood of contralateral adenopathy is increased and bilateral neck dissection is indicated. In most cases this will involve selective neck dissection of levels I through III.

Prosthetic Rehabilitation

Many patients undergoing segmental resection of a mandible in continuity with oropharyngeal cancer will require prosthetic rehabilitation to improve postoperative deglutition and speech function. The goal of such rehabilitation is not replacement of resected bone but obturation of the soft tissue defect resulting from tumor excision. Rehabilitation can begin shortly after the bolus is removed in patients who have undergone reconstruction with a skin graft and once healing has been completed in patients in whom a muscle or skin-muscle flap has been used to close the defect. This process is facilitated by preoperative consultation with a maxillofacial prosthodontist before surgical excision if the patient is able to tolerate oral examination and trismus is minimal. Prosthetic rehabilitation with osseointegrated fixation devices may be appropriate in selected patients. Because of the requirement for postoperative radiotherapy in the majority of these patients, other surgeons elect to not use these techniques out of concern for the long-term effects of radiotherapy-induced bone complications.

TECHNIQUE

In most instances a preliminary tracheotomy is performed to provide maximal exposure of the tumor and to prevent accidental extubation during the mandibulectomy and intraoral tumor excision. Dental extractions may be performed at the beginning of the procedure or at the time of tumor excision. If done by the oral surgical team, it is usually easier to perform the extractions first for scheduling reasons, provided that the patient does not have severe trismus.

Once the neck dissection has been completed, the specimen may be removed or left attached superiorly to the periosteum of the mandible. Dissection is carried over the periosteum of the buccal plate of the mandible anterior to the masseter muscle, and the marginal branch of the facial nerve is elevated with the skin flap. The periosteum is incised inferior to the attachment of the masseter muscle, which is then elevated from the angle of the mandible, depending on the extent of cancer lateral to the mandible (Fig. 33-8). If the tumor has invaded the soft tissue lateral to the mandible or if the prevascular and postvascular nodes are grossly involved with cancer, it may be necessary to sacrifice the facial artery and associated marginal mandibular nerve to widely encompass the cancer. If these nodes are not clinically involved, the marginal nerve must be identified and then isolated and elevated to prevent injury.

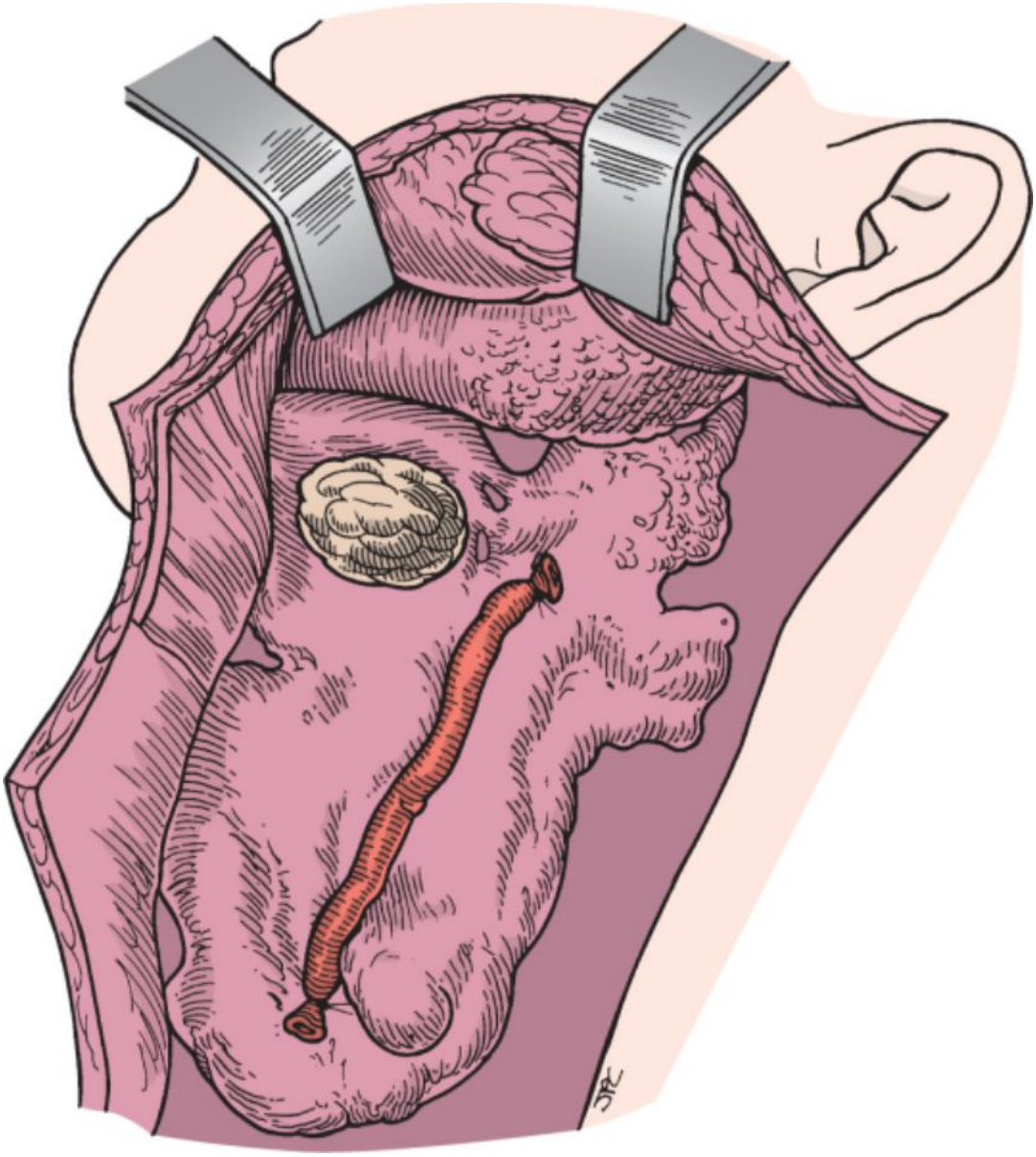

Figure 33-8 Dissection of the mandibular periosteum and masseter muscle lateral to the mandible. Care must be taken to avoid exposing the cancer by excessive dissection superiorly.

The lip is divided in the midline and the skin flap is elevated in continuity with the superiorly based flap. An intraoral degloving incision will have to be made anterolateral to the cancer in the buccogingival sulcus as the cheek flap is elevated (Fig. 33-9). The incision must be tailored to leave an adequate margin (at least 1 cm) as it approaches the tumor. The mental nerve will have to be divided as the skin flap is elevated. This does not increase the morbidity associated with the procedure because the ipsilateral inferior alveolar nerve will be sacrificed at the time of mandibulectomy. A lip-splitting incision results in wide exposure of the mandible, preserves the contralateral mental nerve, and is preferred by most surgeons (Fig. 33-10).

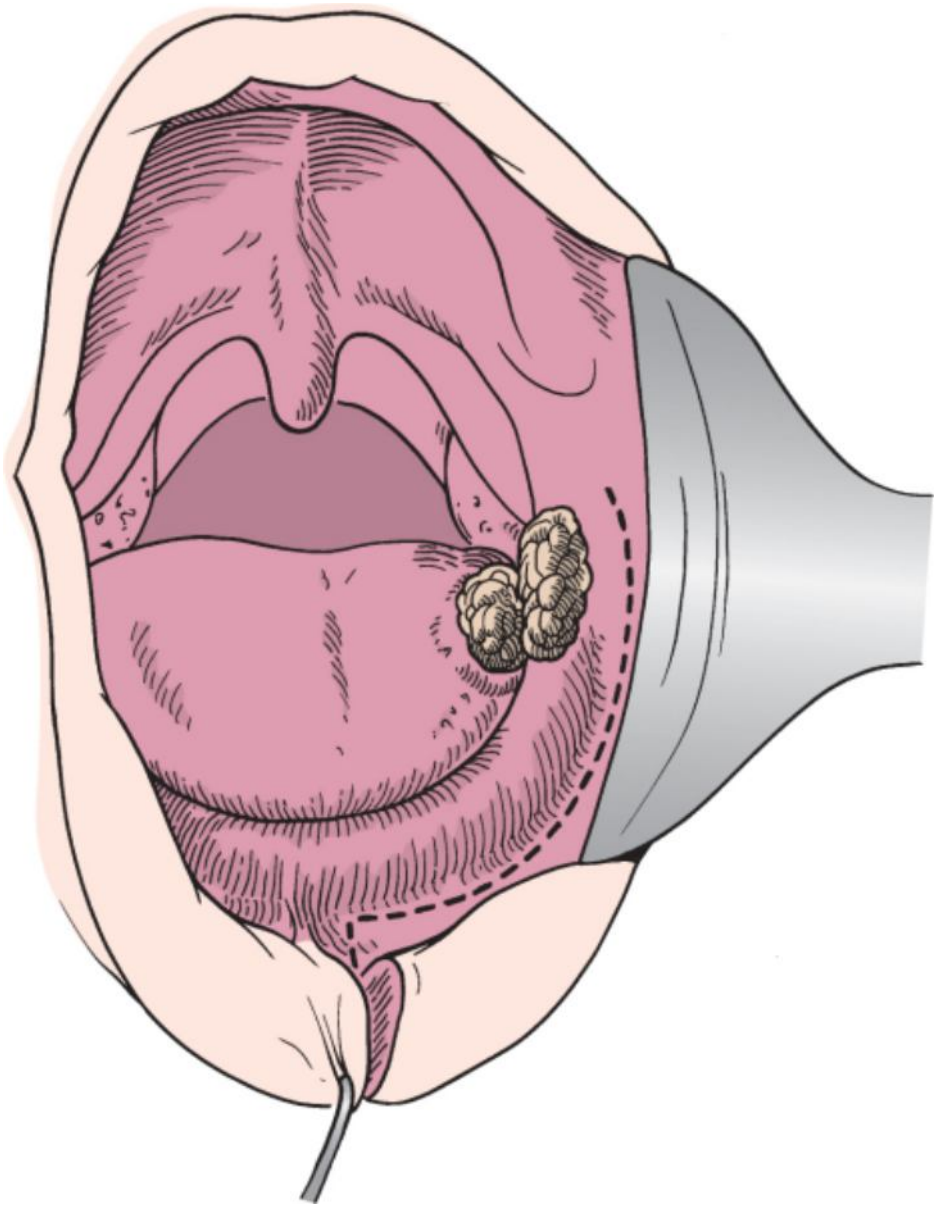

Figure 33-9 A lip-splitting incision with extension along the buccogingival sulcus to permit retraction of the cheek flap. Care must be taken to avoid compromising the tumor margin of resection laterally.

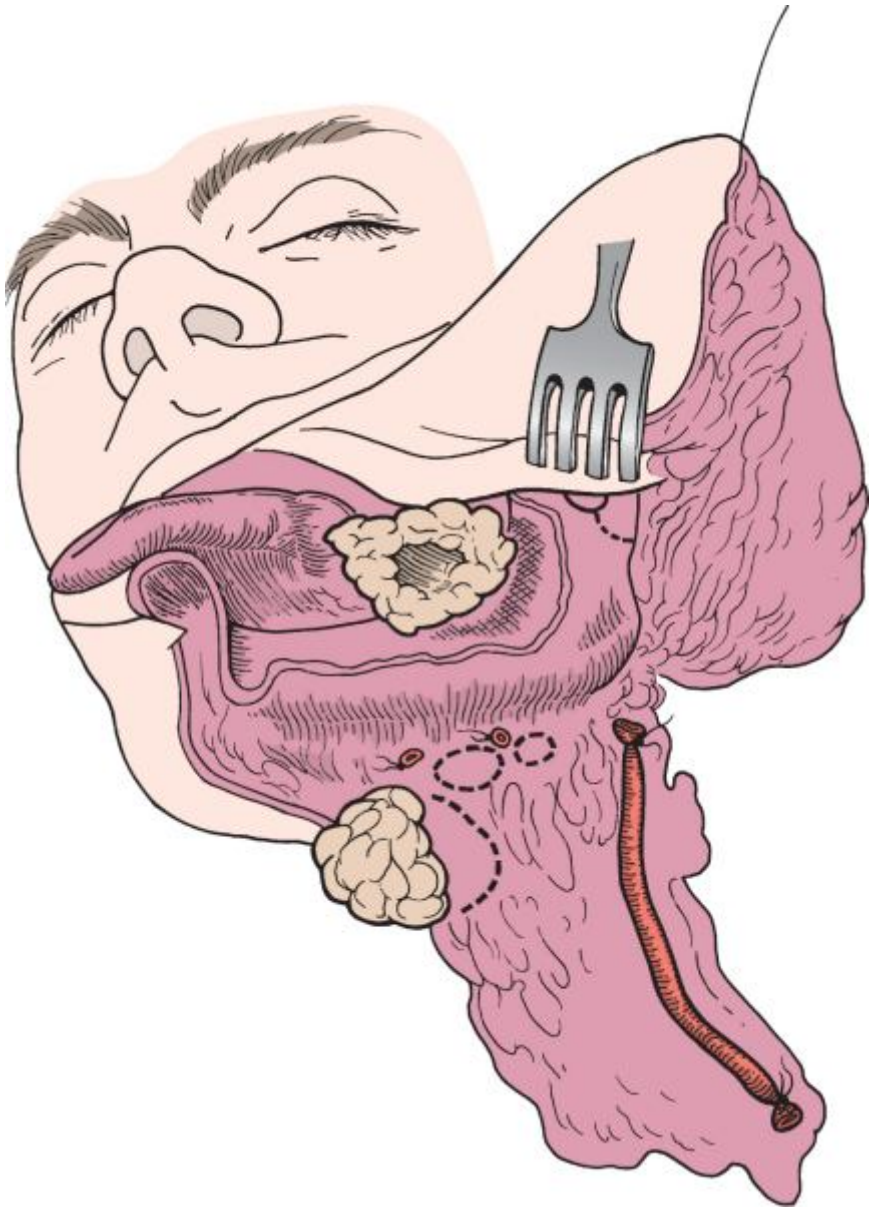

Figure 33-10 Reflection of the cheek flap provides excellent visualization of the cancer.

When a degloving approach is planned, intraoral incisions must be made before entering the oral cavity to ensure appropriate placement of the mucosal incisions. This step requires adequate light and wide opening of the oral cavity with retractors (Fig. 33-11). A suture placed in the tip of the tongue or along the lateral margin of the tongue anterior to the cancer will assist in stretching out the mucosa, thereby easing placement of these incisions. Extending the incision into the contralateral gingivolabial sulcus will be necessary to ensure exposure, and the contralateral mental nerve must be identified and preserved. The neck incision is then connected with the intraoral incision via blunt dissection (if this was not already performed) and carefully extended along the previously made mucosal incision. Care must be taken to not compromise resection of the margins. One or two Penrose drains can be passed through the oral cavity, brought out through the neck incision, and used for retraction of the flap to improve visualization at this point in the procedure.

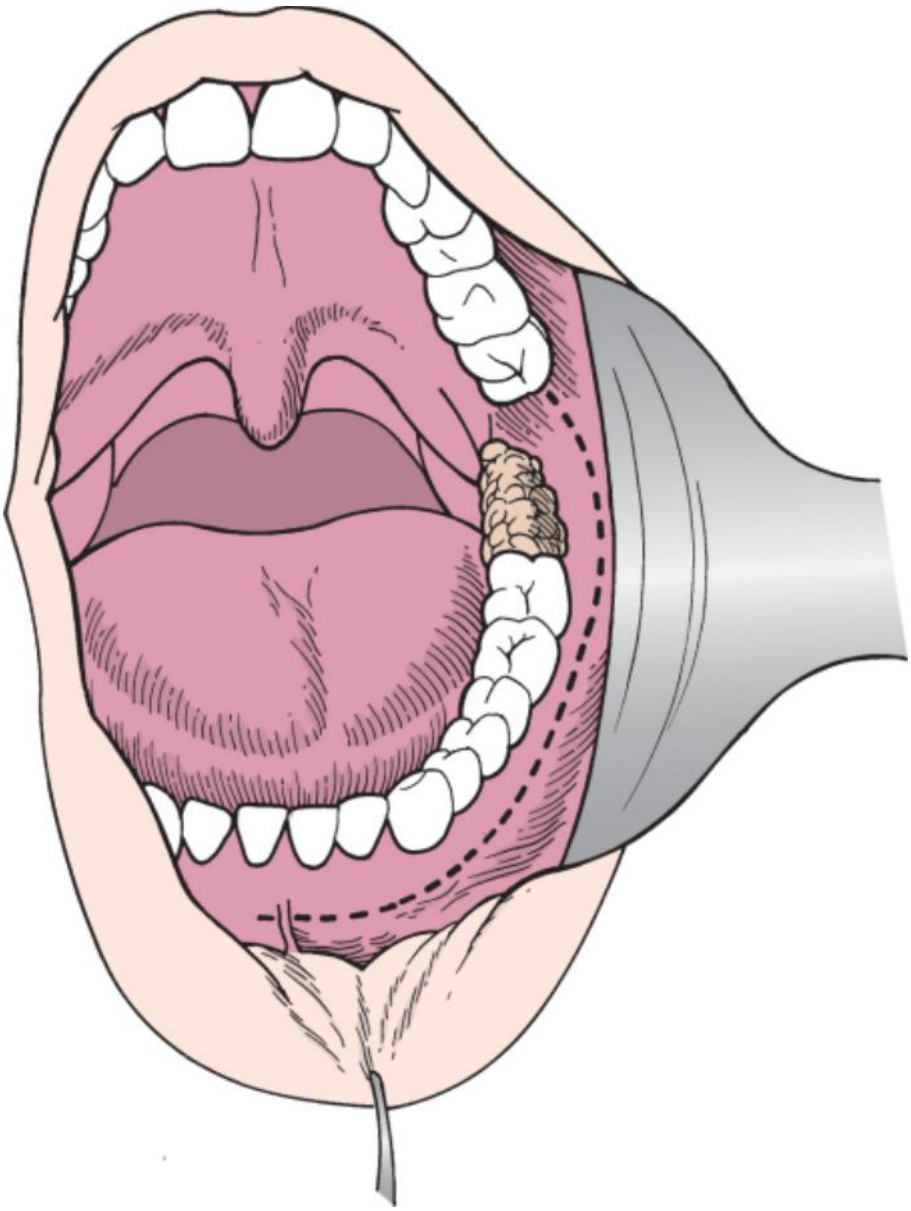

Figure 33-11 A buccogingival incision without a lip-splitting incision to permit elevation of the cheek flap as a "visor." If this incision is selected, care must be taken to avoid sacrificing the contralateral mental nerve.

The reconstruction team may wish to preplate the mandible before mandibulectomy. If this is the case, the reconstruction plate is shaped and screw holes are placed at either end to register the planned residual bone. Because there is usually considerable soft tissue remaining, some adjustment may be necessary. The plate is then removed and must be sterilized to eliminate all cancer cells before reuse at the time of reconstruction.

The anterior position for the mandibular osteotomy is then marked on the mandible. Care must be taken to ensure adequate margins; at the very minimum the mental foramen should be included. This will require bimanual palpation, as well as direct inspection of the tumor.

The osteotomy is then performed with a reciprocating power saw (Fig. 33-12) and continuous irrigation. Face shields are always required by all at the operating table, but they are even more critical when using power saws with irrigation. Appropriate soft tissue retraction helps prevent excessive soft tissue injury. The osteotomy can be facilitated by removal of a tooth from the line of the planned excision. Care should be taken during osteotomy to ensure that adequate bone is left around any remaining dentition. It may be necessary to remove one or more additional teeth to ensure adequate mucosal coverage of the remaining bone. Most of these patients have poor dentition, and typically all the remaining teeth have been removed before tumor excision. It is a grave error to leave poor teeth in place at the time of tumor excision because access to the oral cavity will be severely compromised by the reconstruction, thus making later extraction challenging at best and perhaps even impossible.

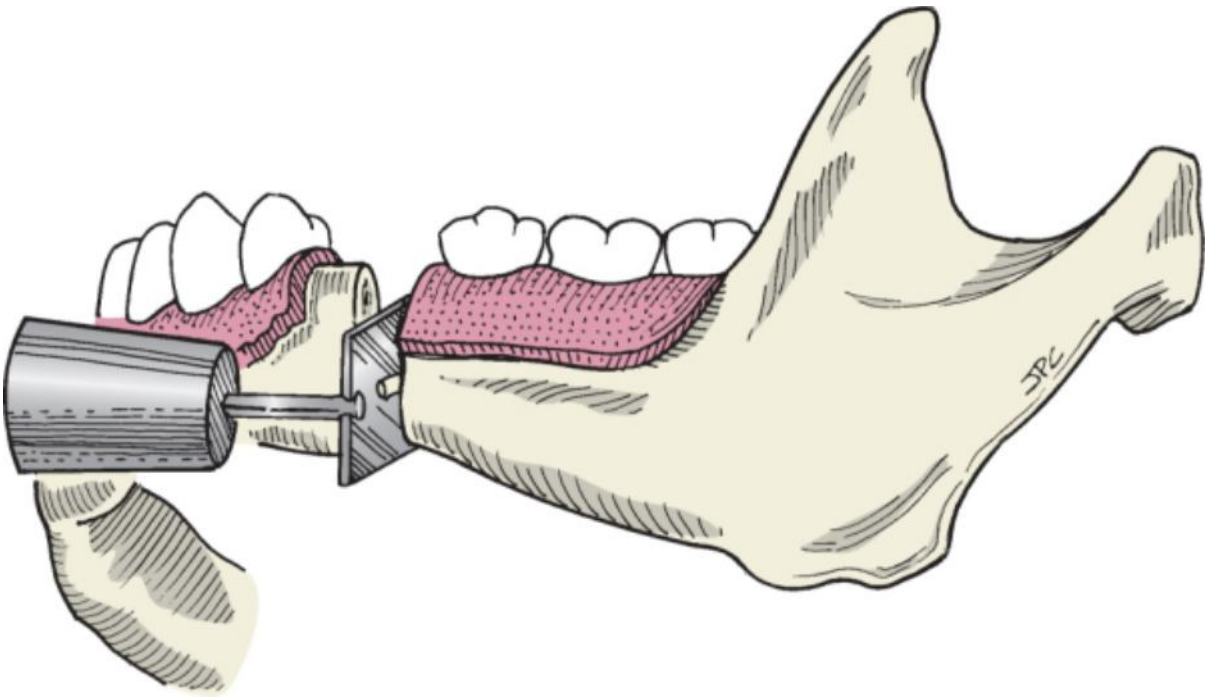

Figure 33-12 An anterior osteotomy is made with a reciprocating power saw. If the patient is dentate, the osteotomy is made through an extraction site.

Excision of the cancer is facilitated by sectioning the ramus of the mandible before excision of the cancer (Fig. 33-13). Lateral retraction of the mandibular segment is limited by the presence of an intact mandible and temporomandibular joint. Depending on the extent of the cancer, this may be performed either below the notch of the mandible, through the notch with section of the coronoid process and a portion of the tendon of the temporalis muscle, by disarticulation of the mandible from the glenoid fossa, or vertically with preservation of the angle and posterior aspect of the ramus. Division of the tendon of the temporalis muscle will be required if the coronoid process is left on the specimen. Disarticulation is somewhat more technically challenging, compromises mandibular reconstruction, and is not generally required. Section of the mandible in the midramus is often associated with significant bleeding because of interruption of the inferior alveolar artery or, occasionally, the internal maxillary artery. Once the osteotomy is completed, any bleeding can usually be controlled expeditiously; therefore, one should not stop midway through the bone cut in an attempt to control the bleeding. Placing the osteotomy near the coronoid notch will minimize bleeding from the inferior alveolar artery.

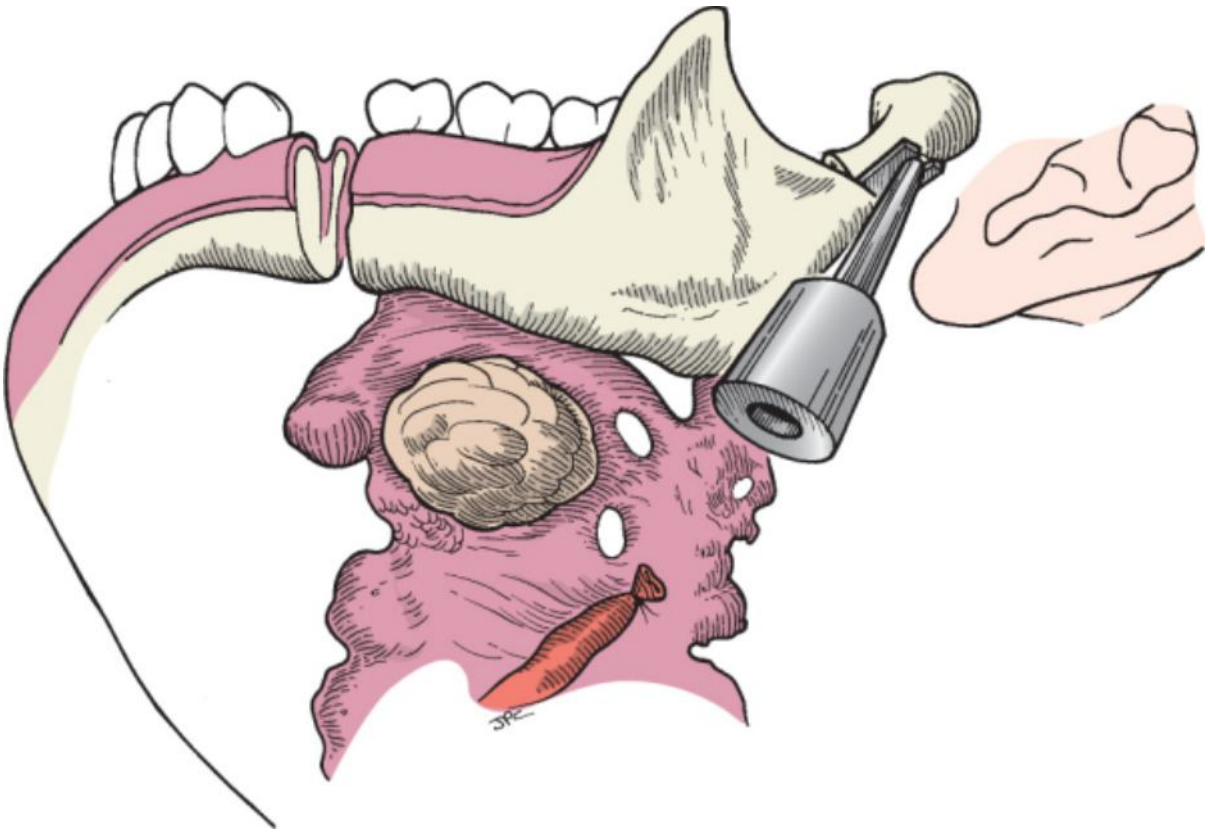

Figure 33-13 An oscillating saw is used for osteotomy of the neck of the mandibular condyle. The osteotomy could also be made through the midramus. If oncologically feasible and reconstruction is planned, a vertical osteotomy provides more bone, thereby improving fixation of the graft.

When both osteotomies have been completed, the mucosal incision can more easily be made around the tumor in the posterior oral cavity. The mucosal incision is extended along the mucosa of the mouth to further expose the tumor (Fig. 33-14). Overexuberant retraction of bone must be avoided to prevent tearing the specimen at this time. Although the lingual nerve can usually be preserved anteriorly, cancer of the posterior oral cavity involving the mandible typically involves or closely approaches the lingual nerve, thereby precluding routine preservation. The inferior alveolar canal is transected at the time of anterior osteotomy, and the inferior alveolar nerve must be sectioned proximally and in the soft tissue incision inferior to the skull base.

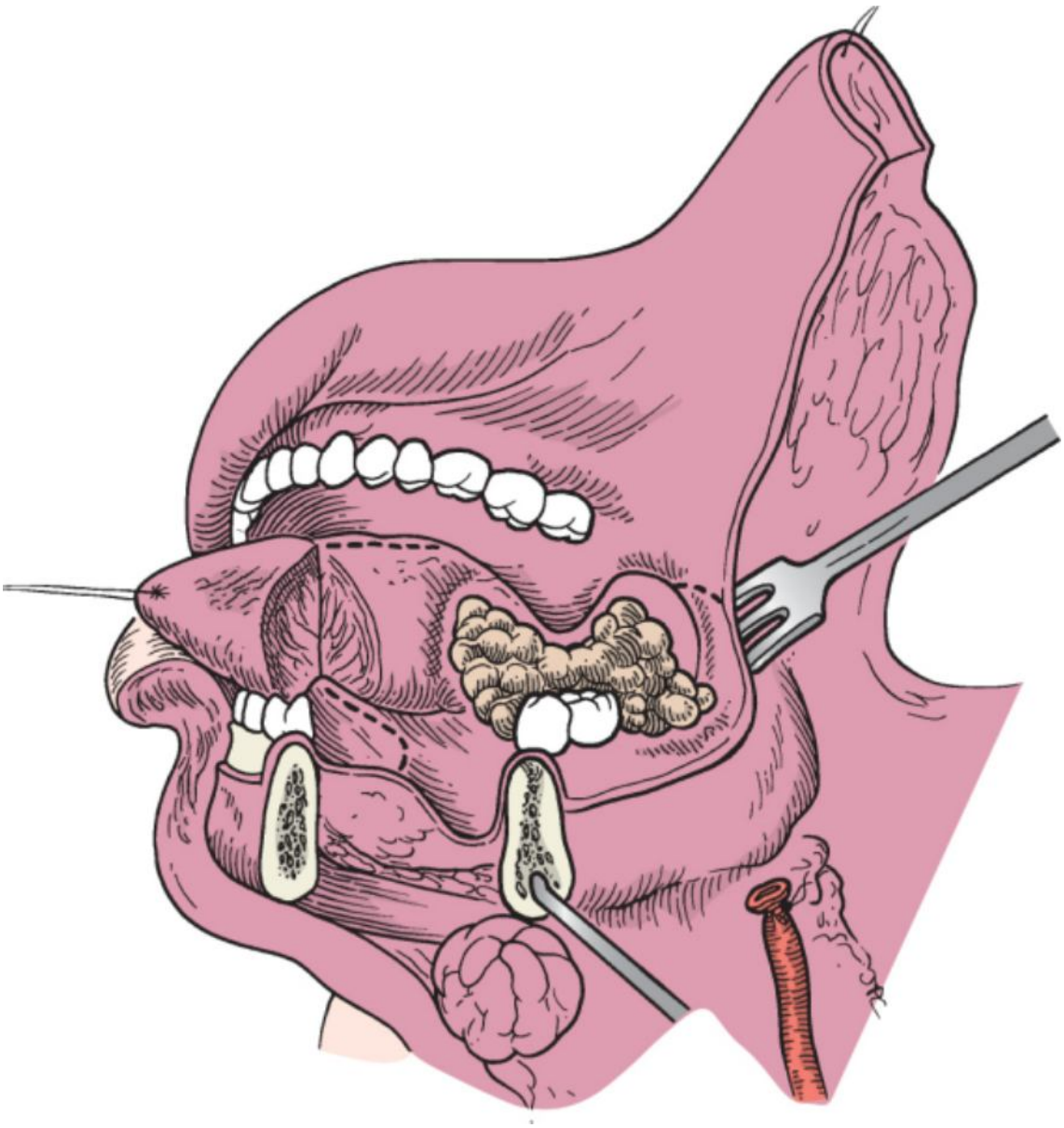

Figure 33-14 The mandible is retracted laterally, and a suture is placed in the tongue to help in retraction and maintenance of an adequate margin around the tumor as it is excised.

Adequate margins must be ensured, particularly posteriorly and superiorly toward the eustachian tube, which tends to be a difficult region to visualize. Spending the extra time to obtain hemostasis before completion of the resection is often valuable in that it aids visualization of the cancer and ensures adequate three-dimensional margins (as well as limits unnecessary blood loss). Care must be taken to avoid tearing the specimen because tearing can make determination of the adequacy of margins difficult for the pathologist, even if the torn specimen is marked by suture.

Excision of the cancer may require resection of a portion of the soft palate. Placement of a suture in the cut end of the soft palate before tumor excision aids retraction and assists in identifying this portion later and orienting the specimen for the pathologist (Fig. 33-15). The excision extends superiorly and laterally, and the medial pterygoid muscles and branches of the mandibular nerve (V3) are divided. This is facilitated by placing a finger behind the specimen to elevate the soft tissue to be cut and to protect the carotid artery posteriorly (Fig. 33-16). It is usually easiest to work circumferentially and gradually narrow the pedicle attaching the tumor to the skull base. Adequacy of excision must be ensured because growth of cancer will typically parallel the branches of V3. Branches of the maxillary artery will be encountered and must be ligated.

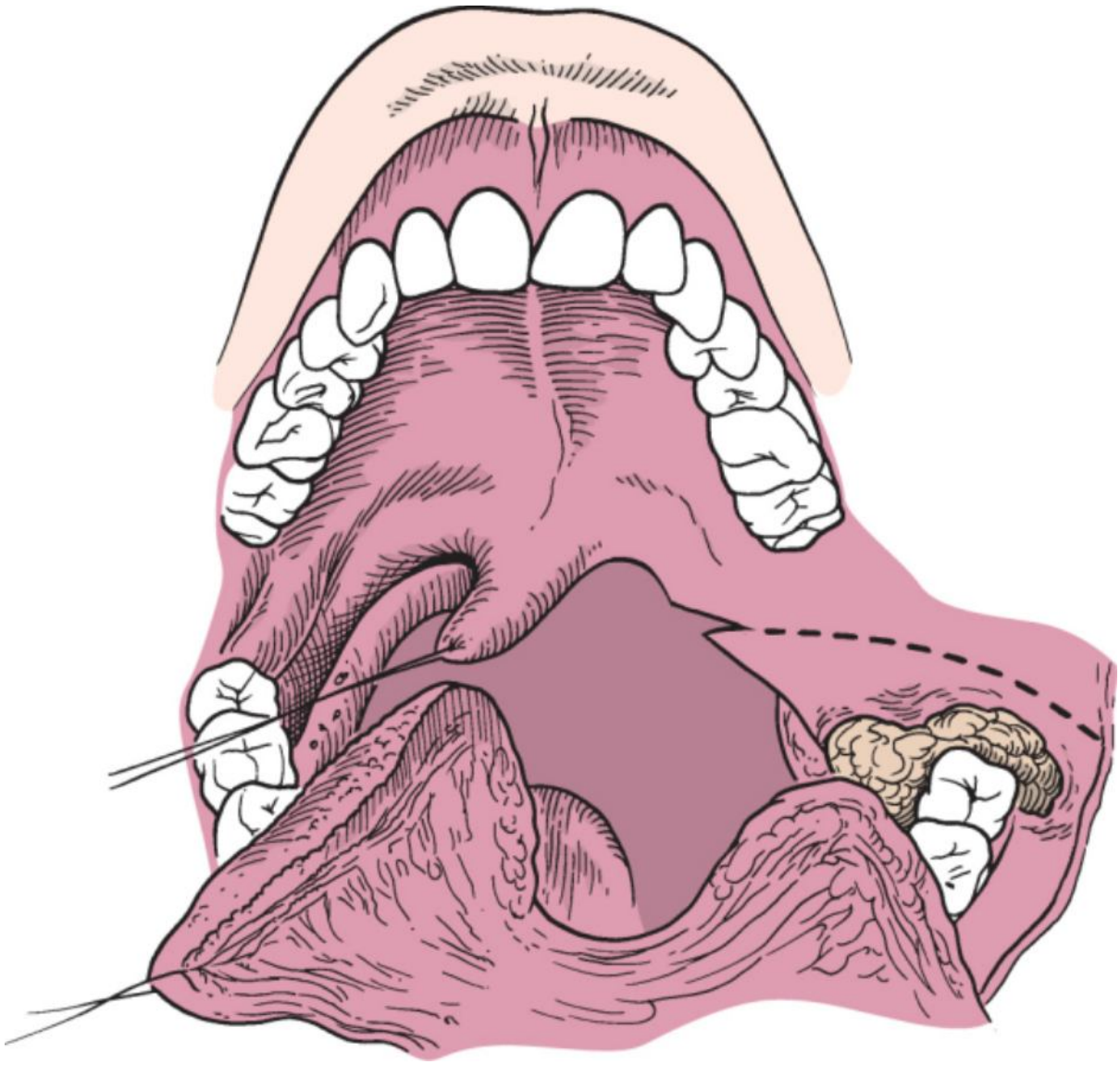

Figure 33-15 Retraction of the soft palate with a suture placed in the uvula will help make precise cuts through the mucosa of the soft palate. It is also advisable to place a suture through the specimen to facilitate orientation by the pathologist.

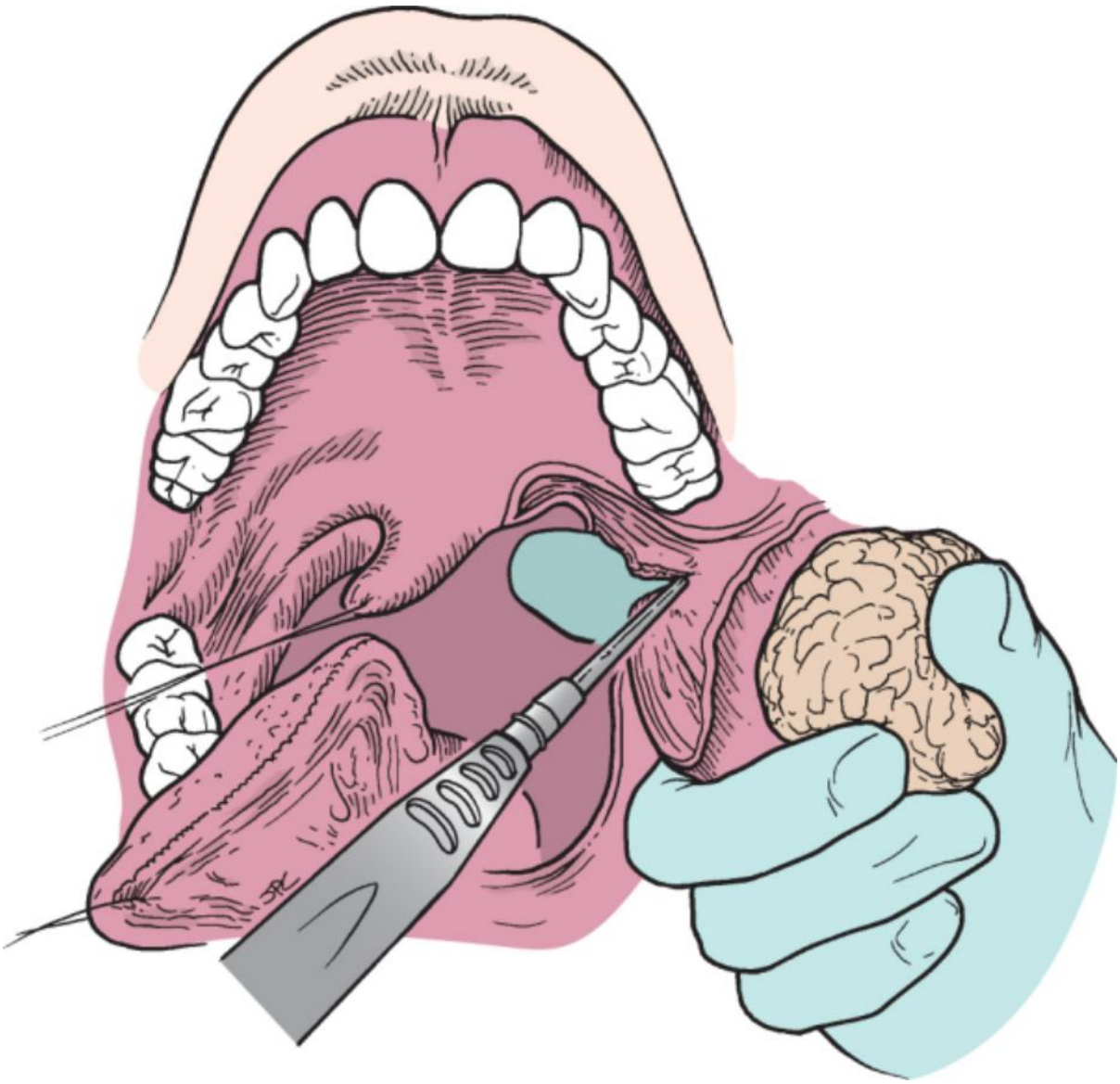

Figure 33-16 The carotid artery is protected by placing a finger posteriorly and amputating the specimen through the pterygoid muscle. Care must be taken to ensure that any tumor extension along the path of V3 is included in this specimen.

When the tumor has been excised, it must be examined carefully by both the surgeon and the pathologist. Orientation of the specimen may be difficult or impossible for the pathologist without the assistance of the surgeon (Fig. 33-17) because of the complex three-dimensional anatomy. Frozen sections are obtained to ensure adequacy of the margins of resection, especially the neurovascular pedicle. Failure to adequately excise the cancer results in recurrent disease and death in essentially all patients.[12] It is preferable to completely excise the cancer at the initial attempt rather than return in several weeks for additional attempts at excision after histologic demonstration of cancerous margins.

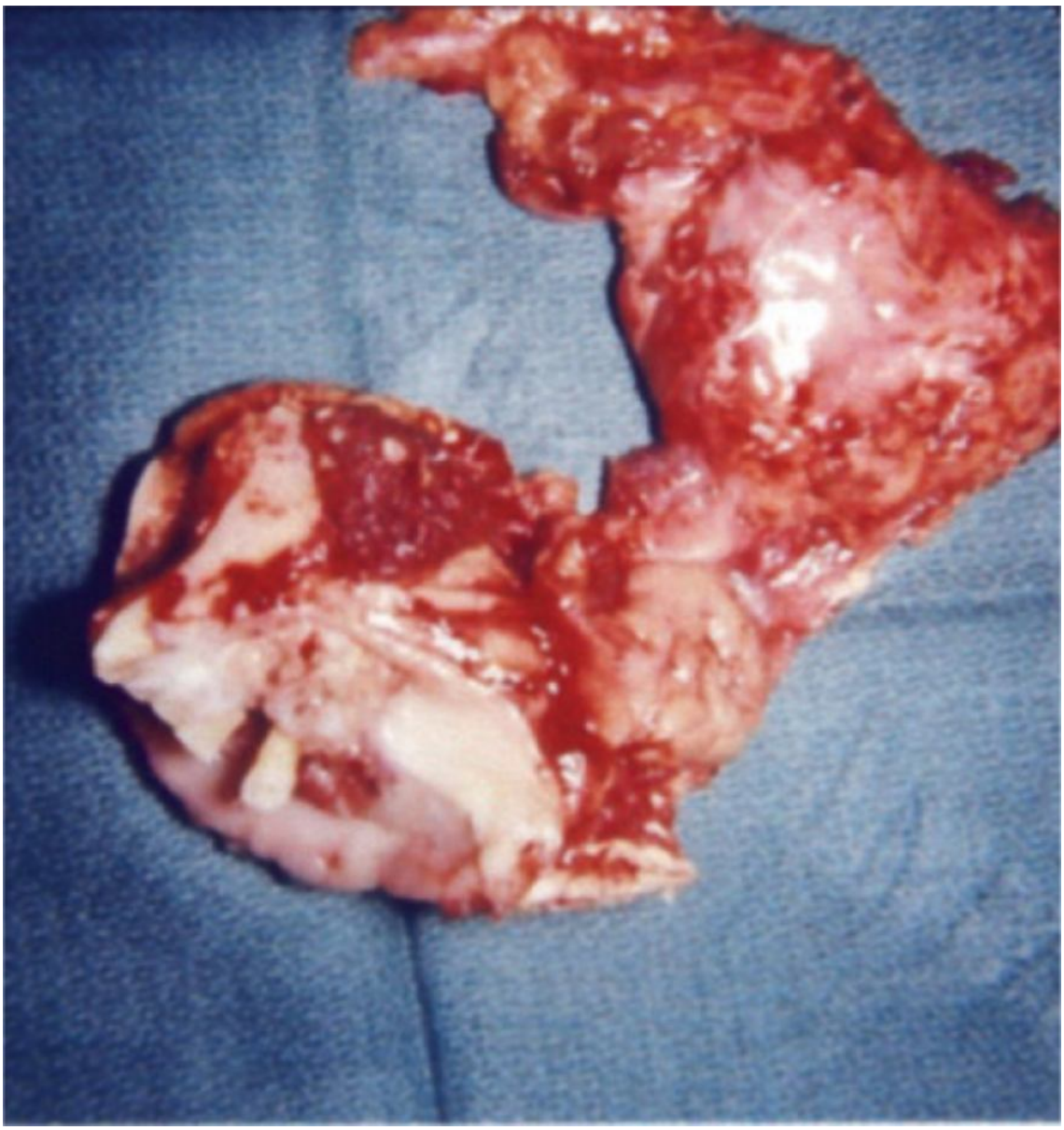

Figure 33-17 Specimen from a composite resection. Identification of margins is difficult because of the complex three-dimensional nature of the resection. Close cooperation between the pathologist and surgeon is mandatory.

Close cooperation between the surgeon and pathologist cannot be overemphasized. We have found that asking the pathologist to come into the operating room to discuss the case and to examine not only the specimen but also the surgical defect is helpful in selecting specific areas for frozen section evaluation. Frozen sections may be taken from either the patient or the specimen, but they must be accurately registered and labeled. When margins are excised from the patient, care must be taken to ensure that the correct portion of the tumor bed is sampled and labeled. The adequacy of bone margins cannot be determined on frozen section because bone must be decalcified before sectioning. Biopsy of the proximal and distal neurovascular bundle may be helpful as a surrogate for adequate bone excision, depending on the location of the tumor.

Reconstruction

After the cancer has been excised and hemostasis ensured, the wound is irrigated and reconstruction can begin. Smoothing the cut end of the bone to prevent sharp edges and allow mucosal coverage is important in preventing postoperative bone exposure, osteomyelitis, and other wound complications. Although smoothing can be performed with a rasp, a rotating burr will speed bone removal. The defect can then be reconstructed as previously planned.

Primary Closure

Primary closure was the traditional, time-honored technique used for many years when bone reconstruction was not performed. Although this technique is not difficult, particularly when excision of soft tissue is minimal, it carries

with it the risk of fixation of oral cavity structures. The resultant tethering of the tongue results in a decrease in postoperative swallowing and speaking ability. Consequently, this technique is used only in unusual circumstances.

Split-Thickness Skin Graft

We prefer a split-thickness skin graft for reconstruction of defects in which bone reconstruction is not planned (Figs. 33-18 and 33-19). The technique is described in detail in Chapter 32. The graft is taken at a thickness of 0.16 inch and sewn in position in a pie crust manner. A bolus of antibiotic-impregnated gauze, typically Xeroform, is placed and tied over with long silk sutures. Watertight closure must be ensured because the skin graft not only resurfaces the defect but also separates the oral cavity from the interstices of the neck during the healing phase. In addition, during placement of suction drains in the neck, the skin graft must not contact the drain or a fistula will result. This error can be prevented by suturing the platysma muscle of the upper flap directly to the digastric sling superior to the drains to reinforce the closure and prevent graft-drain contact.

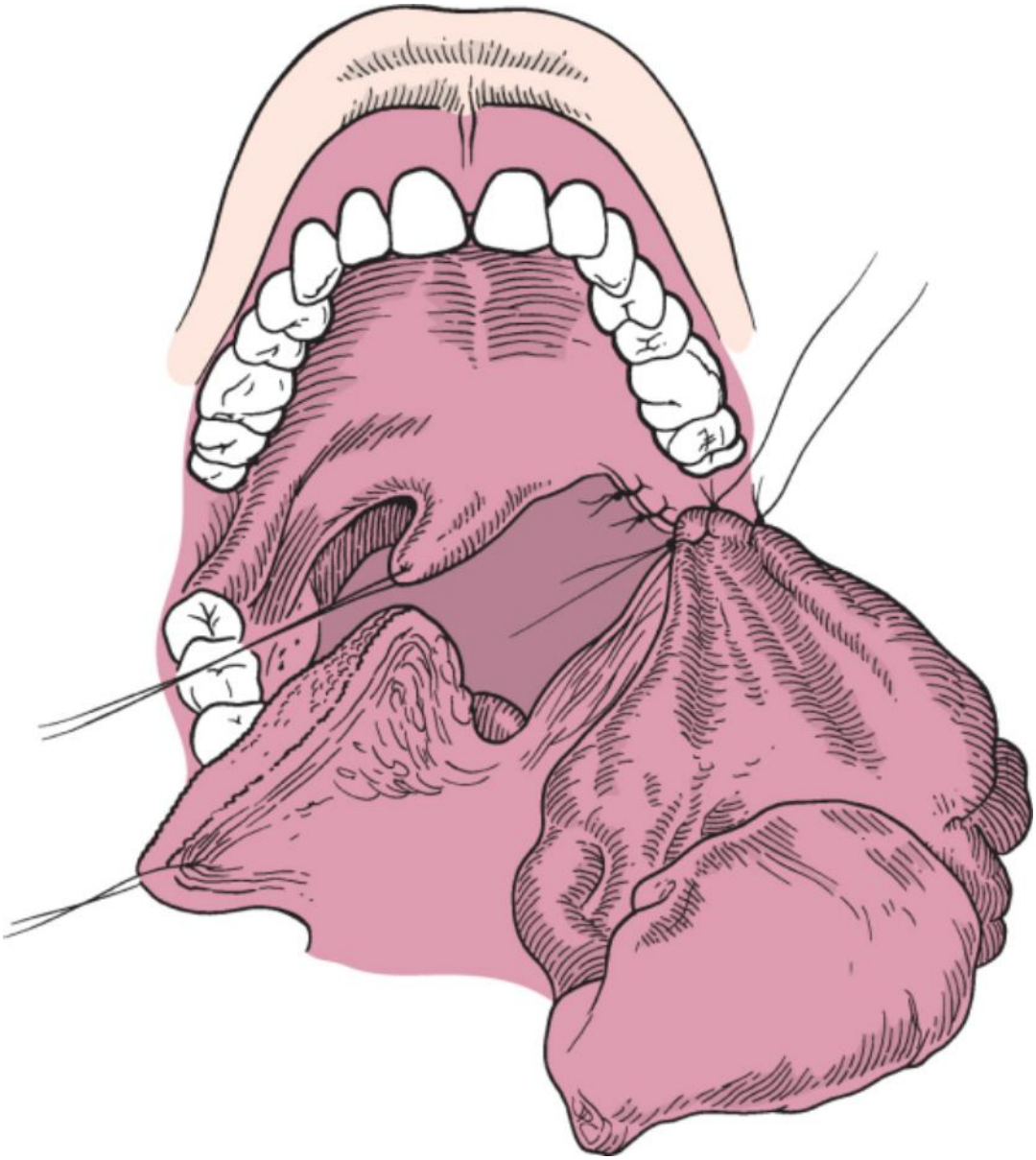

Figure 33-18 A split-thickness skin graft is a satisfactory means of closure. It is usually easiest to begin suturing the graft in position in the most posterior aspect of the wound. Every other suture is left long to tie over the bolus.

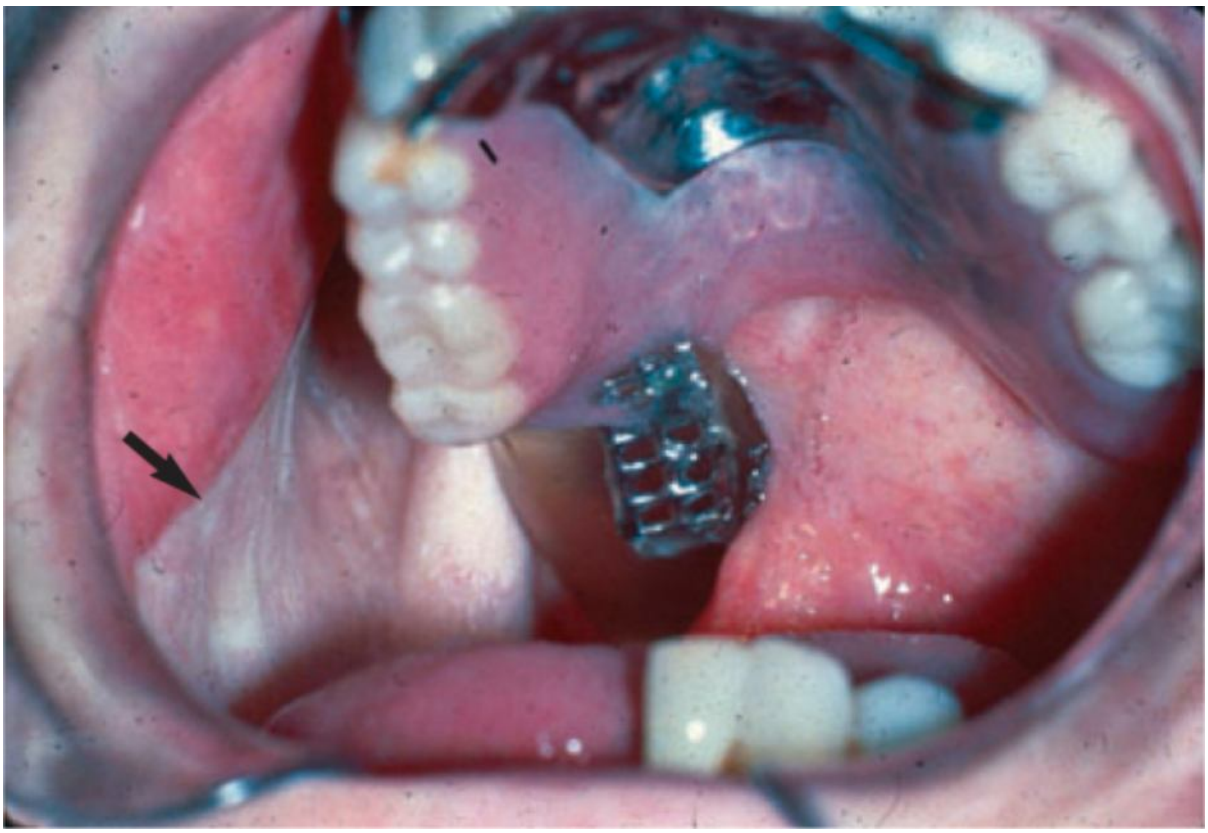

Figure 33-19 A split-thickness skin graft *(arrow)* for resurfacing a defect after composite resection for cancer of the retromolar trigone.

Myocutaneous or Myofascial Flap

Pedicle muscle flaps with or without attached skin are commonly used for closure of soft tissue defects (see Chapter 82). Muscle flaps provide additional bulk and result in a somewhat improved cosmetic appearance, as well as increased protection for the carotid artery. Unfortunately, this increased bulk may cause diminished tongue mobility and decreased oral cavity function, with adverse effects on swallowing and speaking function postoperatively. Nevertheless, this flap technique remains the mainstay of closure in many centers. The flap most commonly used is the pectoralis major based on the thoracoacromial artery. The flap may be used with overlying chest wall skin or as a muscle-fascial flap. The latter technique is preferable when less bulk is desirable because a thin mucosal lining forms over the muscle rapidly. It is best to avoid suturing the flap to the mucosa of the tongue to prevent restriction of tongue mobility. A split-thickness skin graft may be used to re-create a sulcus between the flap and the remaining tongue musculature to avoid tethering. This flap will pivot directly into the defect if the sternocleidomastoid muscle is either resected as part of the neck dissection or disconnected from its inferior attachment to the sternum and clavicle and rotated posteriorly to the muscle flap. Closure should be done in at least two layers to ensure adequate separation of the oral cavity from the neck structures, primarily the carotid artery. Suturing of the flap into position is facilitated by initially placing the flap in position and then rotating it inferiorly and beginning the closure inferiorly. This technique helps ensure complete, sequential closure, thereby avoiding missed areas that result in postoperative leaks.

Mandibular Reconstruction

Mandibular reconstruction has been discussed in the section on patient selection and will not be repeated here. We have favored the radial forearm flap for reconstruction of the mandible (see Chapter 81). The fibular flap has been reserved for cases in which long segments of the mandible must be replaced. The segmental blood supply enhances the ability to fashion the bone by subperiosteal osteotomy and plating to permit reshaping for cosmetic contouring of the graft (Figs. 33-20 and 33-21).[19] Adequate soft tissue is available for reconstruction of soft tissue loss associated with bone excision. This graft has been highly reliable, especially for patients who must undergo removal of the anterior segment of the mandibular arch (Fig. 33-22). Appropriate testing of the blood supply of the lower extremities, such as Doppler studies and arteriography, is essential in patients with a history of peripheral vascular disease.

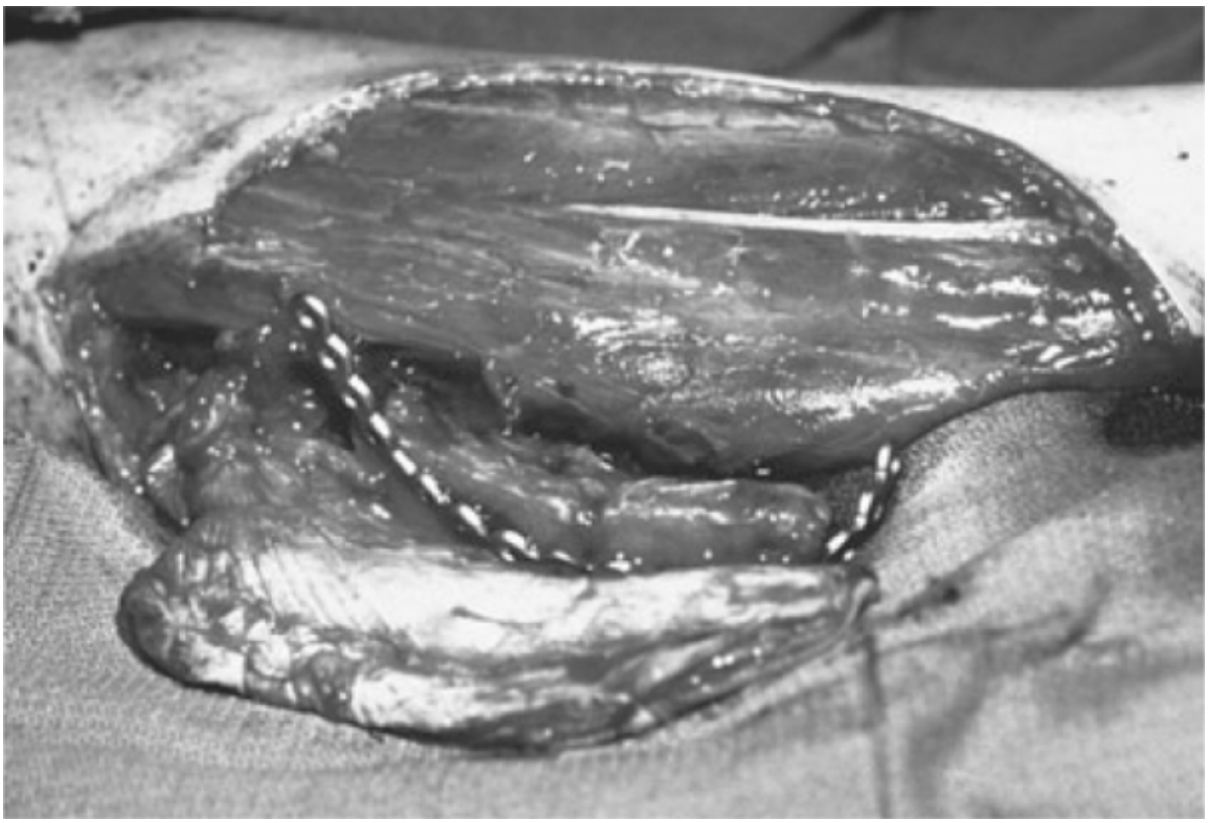

Figure 33-20 Free fibular flap being harvested. Note the multiple osteotomies and the mandibular reconstruction plate used to contour the fibular graft. This can be performed before dividing the vessels.

Figure 33-21 Free fibular graft in place. Adequate soft tissue is available to reconstruct the intraoral defect.

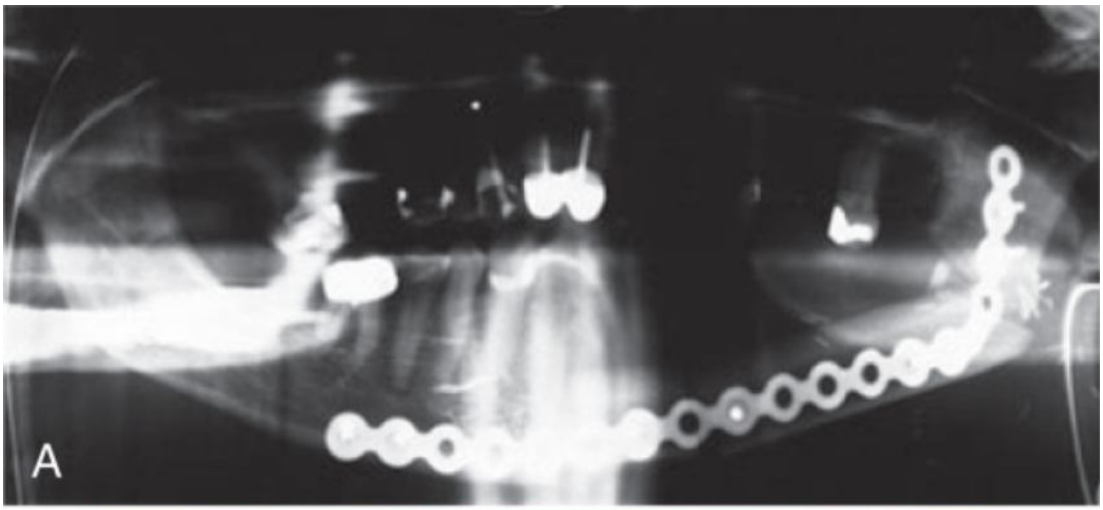

Figure 33-22 **A,** Postoperative Panorex view demonstrating integration of the fibular reconstruction. **B,** A patient with anterior segmental mandibulectomy and reconstruction with a free fibular flap.

POSTOPERATIVE MANAGEMENT

The patient is observed postoperatively in an intensive care unit for 24 to 48 hours. Careful nursing management of the drains and tracheal suctioning are necessary. If a free flap has been used, monitoring of its blood supply with Doppler ultrasound by the nursing staff is critical for success. Oral care should be minimal in the initial stages to preclude traumatization of the closure or disruption of the skin graft bolus. Immobilization of the skin graft bolus by an external compressive dressing is warranted and helpful in ensuring “take” of the skin graft. We use such a compressive dressing in all patients who undergo reconstruction with a skin graft unless bilateral neck dissection has been performed. We do not use a dressing in patients who have undergone flap reconstruction (either pedicled or free microvascular) for fear that the dressing could lead to venous congestion of the flap and result in tissue is-chemia and necrosis.

Perioperative antibiotics are continued for 24 hours. Continuation of antibiotics beyond 24 hours has not been shown to be efficacious and may lead to colonization with resistant organisms.[20] The single most important factor in prevention of postoperative wound infections is assurance of a watertight seal during wound closure—hence the emphasis on reconstructive techniques.

If reconstruction with a skin graft was performed, the bolus is removed in 5 days. The entire bolus must be removed. Counting the number of pledgets of packing placed within the bolus at the time of the surgical procedure and then recording this number in the operative note helps avoid inadvertently leaving a portion of the bolus within the defect.

Decannulation can begin when the bolus has been removed from the oral cavity or the flap is healing well. We do not begin oral feeding until the decannulation process is complete and the tracheostomy has closed.

SUMMARY

Cancer of the oral cavity involving bone requires segmental mandibulectomy to ensure adequate ablation. Margins must be adequate, or local recurrence of tumor is inevitable. Mandibular continuity can be re-established with the use of various vascularized bone grafts, of which the radial forearm is the preferred choice. Isolated lateral defects may not require reconstruction; however, anterior defects should be reconstructed to facilitate rehabilitation and postoperative oral cavity function. A novel means of mandibular “reconstruction” involving the use of distraction osteogenesis may offer patients improved reconstructive options.

PEARLS

- Marginal mandibulectomy is preferred over segmental mandibulectomy whenever oncologically feasible.
- Not all lateral segmental resections need to be replaced, and the decision regarding reconstruction of the lateral mandible should be made on a case-by-case basis.
- All anterior mandibular segmental defects must be reconstructed to avoid major cosmetic and functional defects.
- Preplating the mandible before resection can assist in accurate reconstruction and occlusion.
- The success of free flap reconstruction depends on excellent nursing care.

PITFALLS

- Failure to achieve negative margins is usually due to underestimating tumor extent preoperatively.
- Tumor can extend into soft tissue at the site of the mental foramen. Biopsy of this region should be considered in cases in which the inferior mandibular neurovascular canal is involved with tumor.
- Skin grafts will not adhere to cortical bone.
- Osteoradionecrosis may occur if all diseased teeth are not removed.
- Frozen section analysis of bone margins is not a possibility, so a generous margin of bone must be taken to avoid positive margins.