Chapter 81 – Microvascular Reconstruction of the Head and Neck

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The goals of reconstruction are to restore premorbid function and quality of life. Successful reconstruction requires careful consideration of both the surgical defect and patient-specific variables, such as general health, radiation status, and dental rehabilitation. Cardiac, vascular, and pulmonary disease, as well as alcoholism, are common in patients with cancer of the head and neck and may independently have an impact on survival and limit reconstructive options. For example, the fibula would be a poor donor site in an individual with severe lower extremity peripheral vascular disease. Radiation induces soft tissue fibrosis, in particular, perivascular fibrosis. Therefore, a history of previous radiation therapy with its anticipated decreased vascularity may guide reconstructive options toward using a pedicled or free flap instead of a skin graft.

The anticipated defect should be classified according to the extent of rigid, soft tissue, and neurologic components. When possible, resected tissue should be reconstructed with tissue that duplicates both the appearance and the function of the resected tissue. Epithelium can be used to resurface mucosal or skin defects, muscle can be used to restore bulk and motion, and palatal and mandibular skeletal defects can be reconstructed with bone. Skin grafts, local or regional flaps, prosthetic devices, and free tissue transfer are among the range of options that the reconstructive surgeon must possess to customize the reconstruction to an individual patient.

Free tissue transfer offers a well-accepted, superior ability to restore form and function with certain major head and neck defects. Microvascular surgery provides distinct advantages for reconstruction of osseous defects of the mandible, large glossectomy defects, total or near-total pharyngeal defects, and complex defects of the midface and skull base.

PATIENT SELECTION AND PREOPERATIVE EVALUATION

Early experience with free flaps was primarily concerned with free skin flaps (i.e., the free groin flap and free dorsalis pedis artery flap). As experience with microsurgery grew and knowledge about vascular anatomy expanded, transfer of musculocutaneous and osteocutaneous flaps became as commonplace as transfer of free cutaneous flaps. Theoretically, any tissue with a defined vascular circuit can be transferred as a free flap, but for head and neck reconstruction, eight free flaps are particularly useful: the radial forearm, parascapular and scapular, lateral arm, rectus abdominis, fibula, iliac crest, and anterolateral thigh flaps.

Radial Forearm Free Flap

The radial forearm free flap (RFFF) is a fasciocutaneous free flap that derives it blood supply from branches of the radial artery running in the intermuscular septum between the brachioradialis and flexor carpi radialis muscles.[1] The major advantage of the RFFF is the large amount of thin forearm skin that can be harvested for reconstruction of any associated intraoral or external skin defect. A segment of radius vascularized by vessels passing from the radial artery through the lateral intermuscular septum and perforating vessels through the muscle belly of the flexor pollicis longus may be transferred with the RFFF (Fig. 81-1). Approximately 10 cm of bone can be harvested between the insertion of the pronator teres and the insertion of the brachioradialis. A “boat-shaped” osteotomy as opposed to right-angle bone cuts may help avoid the complication of fracture.[2] Only 30% of the cross-sectional area of the radius should be removed to preserve the structural integrity of the radius. Provided that the periosteum is carefully preserved on the volar and radial aspects of the segment of the radius, one or two osteotomies may be performed from the medullary aspect to allow reconstruction of anterior symphyseal and parasymphyseal defects. Whereas the anterior projection of the anterior mandible can be re-created with an osteotomized radial forearm osteocutaneous flap, the vertical height of the anterior mandible cannot be created. The bony segment of the radius is usually too thin to allow placement of osseointegrated implants. The antebrachial cutaneous nerves of the forearm can be incorporated into the flap to make the RFFF a sensate flap. However, spontaneous return of flap sensation has been documented in patients who underwent reconstruction of the oral cavity with noninnervated flaps.[3]

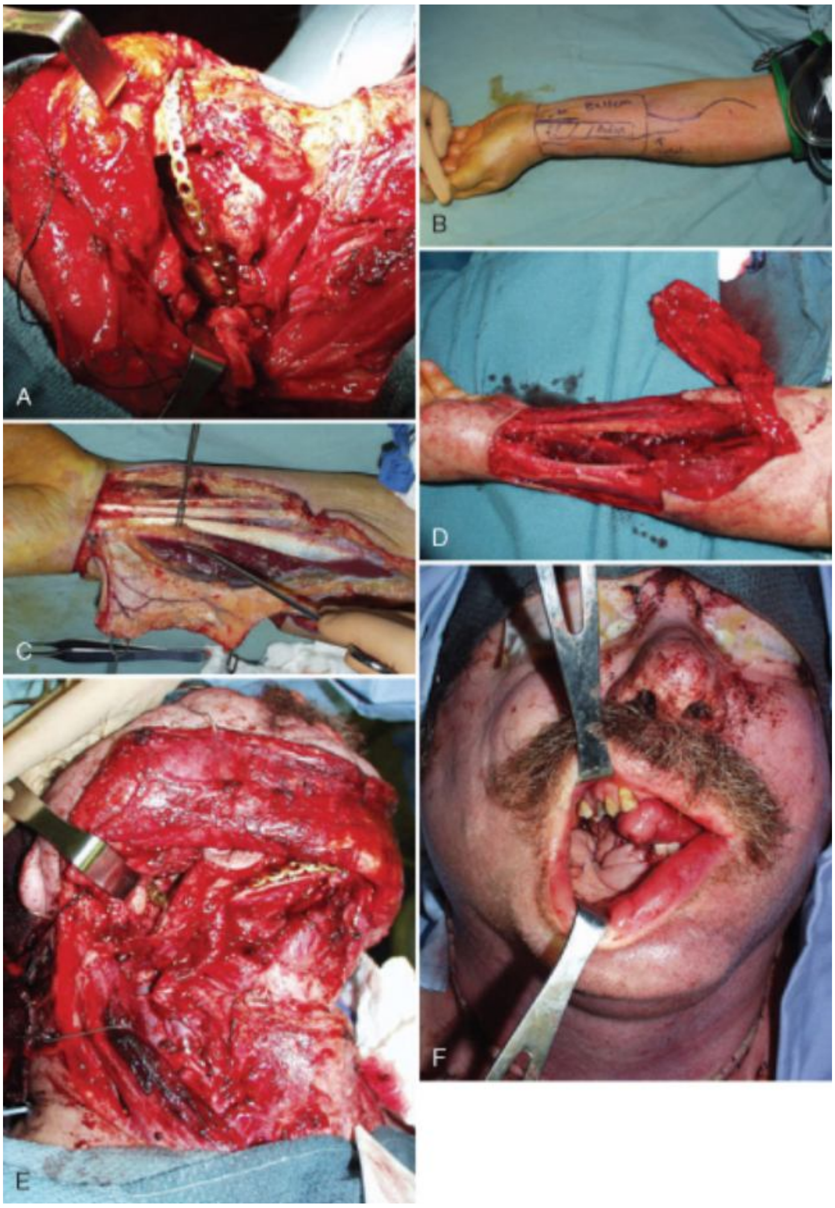

Figure 81-1 Osteocutaneous radial forearm free flap for a lateral mandibular defect. **A,** Lateral mandibular and floor of the mouth defect after resection of T4 carcinoma. **B,** Flap design with the radius, skin paddle, cephalic vein, and radial artery marked. **C,** Perforators to the radius from the radial artery traversing through the flexor pollicis longus and pronator quadratus identified. **D,** Keel-shaped osteotomies from the insertion point of the brachioradialis to the origin of the pronator teres. **E,** Inset of the radius with the skin paddle used for reconstruction of the floor of the mouth. **F,** Final closure.

An Allen's test should be performed before harvesting or RFFF to assess the adequacy of ulnar collateral circulation to the hand. If a positive Allen's test is detected, one should use a different flap for reconstruction or be prepared to replace the radial artery with a vein graft.

Scapular and Parascapular Fasciocutaneous and Osteocutaneous Flaps

The branching pattern of the circumflex scapular artery and vein permits the harvest of a number of fasciocutaneous and osteocutaneous flaps for reconstruction of the oral cavity. The scapular flap is based on the horizontal cutaneous branch of the circumflex scapular artery (Fig. 81-2). The parascapular flap is based on the descending cutaneous branch of the circumflex scapular artery. Up to 14 cm of the lateral border of the scapula vascularized by periosteal branches from the circumflex scapular artery and vein can be isolated. Unlike other osteocutaneous flaps, the scapular bone and the two skin paddles can be orientated independently of one another for reconstruction of complex three-dimensional defects.[4] In addition, the latissimus dorsi and serratus anterior muscles vascularized by the thoracodorsal artery and vein can be harvested with the scapular flaps based on the common vascular pedicle of the subscapular artery and vein.

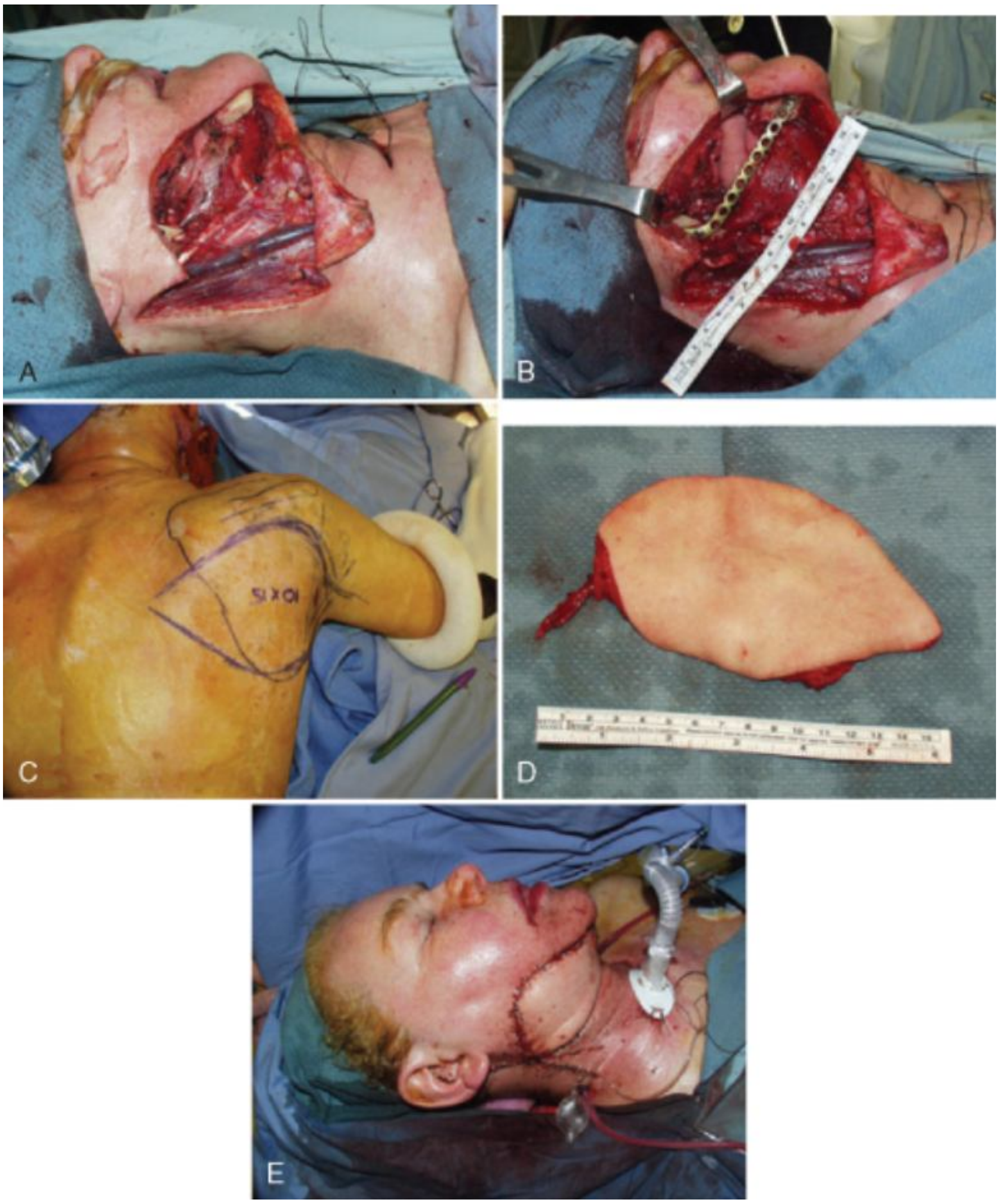

Figure 81-2 Scapular fasciocutaneous flap. **A,** Composite resection of the lateral mandible, floor of the mouth, and cheek skin. **B,** Mandibular continuity restored with a reconstruction plate. **C,** Flap design. **D,** Scapular flap harvested. **E,** Flap inset with a strip of skin de-epithelialized to allow two skin paddles—one for the cheek and neck skin and one for reconstruction of the floor of the mouth.

The disadvantages of these flaps are that they require harvesting in the lateral position, the lateral border of the scapula is quite thin and may preclude secondary osseointegration, and the segmental periosteal blood supply may be compromised if multiple osteotomies are required to shape the scapula for anterior defects. The skin on the back can also be the thickest in the body, and with obesity these flaps can be quite thick.

Lateral Arm Flap

The lateral arm flap is a reliable fasciocutaneous flap that has the distinct advantages that its vascular supply, the profunda brachii artery, is a nonessential artery whose harvest does not jeopardize the vascular supply to the upper extremity and the donor site can be closed with a linear scar.[5] The axis of the flap is centered on the lateral intermuscular septum, which is located between the triceps posteriorly and the brachialis and the brachioradialis anteriorly (Fig. 81-3). After the profunda brachii branches from the brachial artery, it travels in the spiral groove with the radial nerve. As the profunda brachii enters the septum, it divides into anterior and posterior radial collateral arteries. The posterior radial collateral artery supplies the lateral arm flap. The vascular pedicle is usually ligated in the spiral groove, but additional length can be obtained by dissecting deep to the lateral and long head of the triceps. The posterior cutaneous nerve of the arm, which is closely associated with the posterior radial collateral artery, can be incorporated into the flap to make the lateral arm flap a sensate flap. Donor site complications, including radial nerve palsy and hyperesthesia of the proximal lateral forearm skin caused by damage to the posterior cutaneous nerve of the forearm, have been reported but are seldom seen.

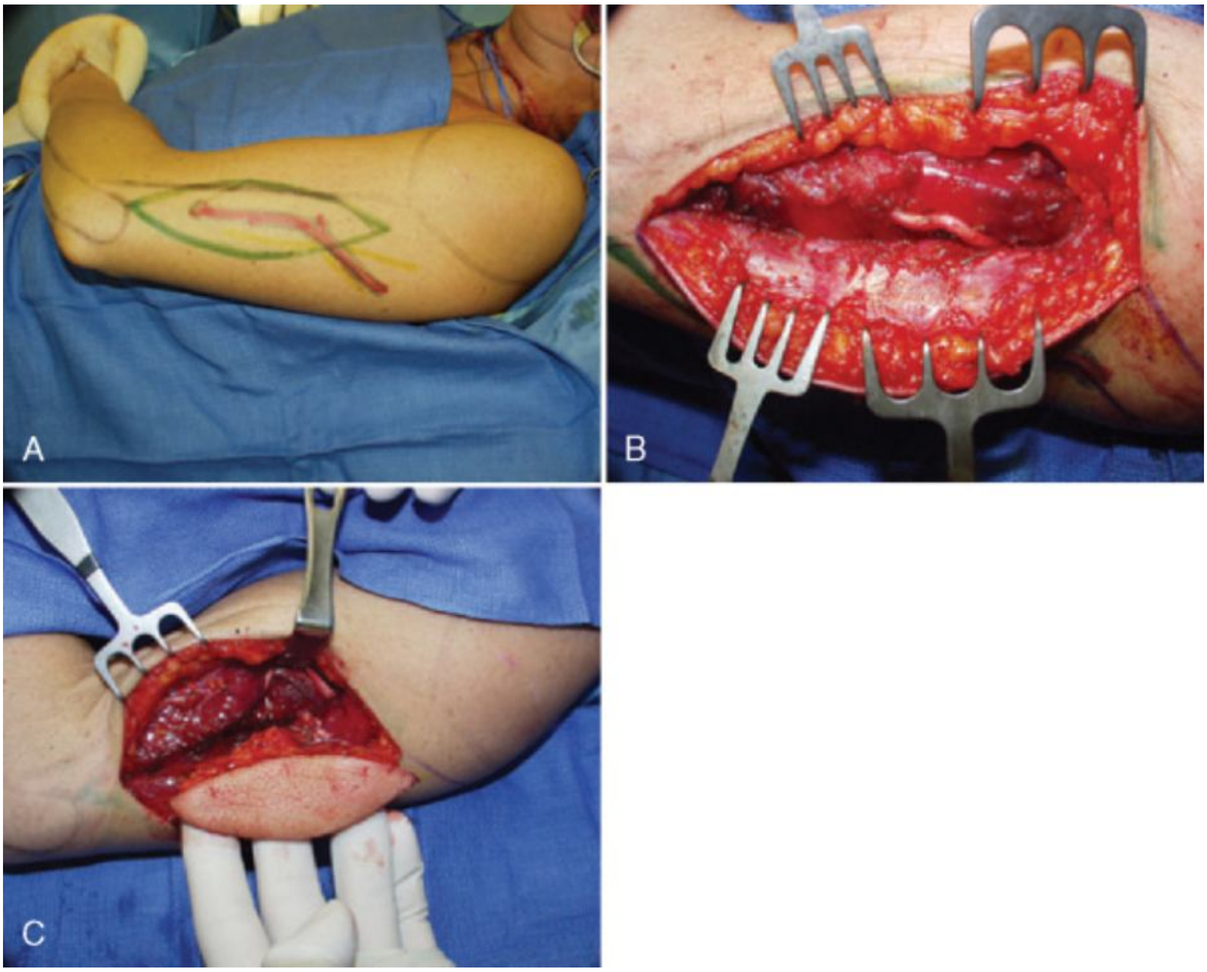

Figure 81-3 Lateral arm flap. **A,** Flap design with the position of the posterior radial collateral artery marked in red. **B,** Radial nerve identified. **C,** Flap harvested.

Rectus Abdominis Free Musculocutaneous Flap

The rectus abdominis free musculocutaneous flap is based on periumbilical perforators from the deep inferior epigastric arteries.[6] Incorporation of the periumbilical perforators permits the skin paddle to be oriented in virtually any direction from the midline (Fig. 81-4). After the perforators are identified, the anterior rectus sheath is incised medial to the linea semilunaris and lateral to the linea alba. To preserve the strength of the abdominal wall, the anterior rectus sheath should not be harvested below the arcuate line. Inferiorly, the anterior rectus sheath is incised vertically to completely expose the rectus muscle. The deep inferior epigastric pedicle is identified after the rectus muscle is bluntly dissected free from the posterior rectus sheath. The vascular pedicle, up to 15 cm in length, is exposed all the way to the origin of the vessels from the external iliac artery and vein. The intercostal nerves that supply the rectus muscle and overlying skin are mixed sensory and motor nerves, but microanastomosis to a sensory nerve in the head and neck has not yet resulted in a report of restoration of sensation. Closure of the abdominal wall can be accomplished by direct approximation of the residual anterior fascial margins. Few reports have quantified the functional effect of harvesting a single rectus muscle on lifestyle. Most surgeons would agree that unless patients are engaged in vigorous physical activity, harvest of a unilateral rectus muscle has little impact.

Figure 81-4 Rectus myocutaneous free flap. **A,** Total orbitomaxillectomy defect. **B,** Flap design with two skin paddles—one for orbit and cheek skin reconstruction and the other for palate reconstruction. **C,** Postoperative frontal view. **D,** Postoperative view of the palatal reconstruction.

Fibular Free Flap

The fibula is our first line choice for mandibular reconstruction (Fig. 81-5). It can be transferred as a free osseous, free osteocutaneous, or free osteomuscular flap.[7] The skin of the lateral aspect of the calf is supplied by septocutaneous perforators that traverse the posterior crural septum between the posterior compartment muscles (the gastrocnemius and soleus) and the lateral anterior compartment muscles (the peroneus longus and brevis). Musculocutaneous perforators that run through the flexor hallucis and soleus may also supply the skin. Consequently, when harvesting an osteocutaneous fibular flap, one should include a cuff of flexor hallucis and soleus muscle to protect these perforators. Even with care taken to protect the septocutaneous and musculocutaneous perforators, loss of the skin paddle has been reported in 5% to 10% of cases. The fibula may be harvested with a lateral cuff of soleus muscle without a skin paddle and be used to replace oral lining by allowing the exposed muscle to mucosalize. The fibula will provide up to 26 cm of bone vascularized by the peroneal artery and its two venae comitantes. The peroneal artery provides both endosteal and periosteal blood supply to the fibula, and consequently blood supply to multiple bony segments of the fibula can be maintained through these segmental periosteal perforators after multiple osteotomies of the fibula. The cross-sectional area of the fibula approximates the cross-sectional area of the midbody of the mandible and is ideally suited for placement of osseointegrated implants for dental rehabilitation.

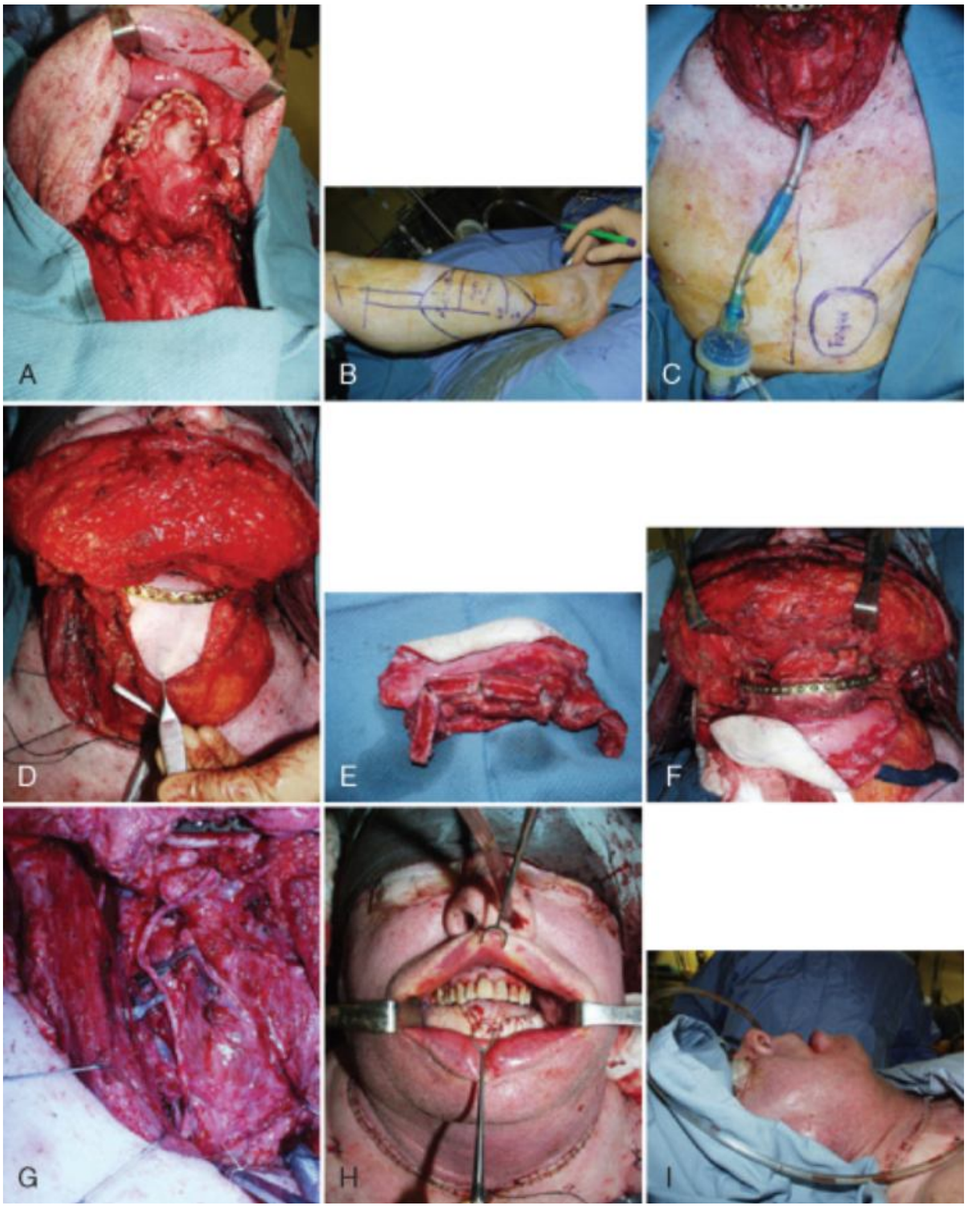

Figure 81-5 Fibular osteocutaneous free flap and pectoralis major myocutaneous flap for near-total mandibulectomy and total glossectomy. **A,** Near-total mandibulectomy and total glossectomy defect. **B,** Osteocutaneous fibular free flap design with the skin perforators (P) marked. The skin paddle is to be used for floor of the mouth and anterior tongue reconstruction. **C,** Pectoralis flap for posterior tongue reconstruction. **D,** Inset of the pectoralis flap. **E,** Closing wedge osteotomies of the fibula. **F,** Inset of the fibular free flap with the skin paddle to be rotated over the plate and sewn to the pectoralis flap. **G,** Inset of the greater saphenous vein graft into the proximal internal jugular vein stump. Both internal jugular veins had been ligated during the resection. **H,** Final inset—oral cavity. **I,** Final inset—lateral view.

The need for preoperative vascular assessment before fibular transfer is controversial. Large series performed without preoperative imaging have reported no adverse sequelae, yet given the prevalence of risk factors for peripheral vascular disease in the head and neck cancer population, others have stressed the need for vascular evaluation. According to Futran and colleagues, ankle-arm index screening and color flow Doppler imaging may be more economical and efficient ways to evaluate the vasculature of the lower extremity than angiography or magnetic resonance angiography.[8]

Two criticisms of use of the fibular free flap have been the height discrepancy between the fibular bone and the native mandible and the inability to reconstruct associated large soft tissue defects (e.g., large glossectomy defects or through-and-through defects). Re-cent innovations have addressed these criticisms. Jones and associates described a “double-barrel” technique in which the fibula is folded on itself to effectively double the height of the neomandible.[9] In conjunction with a fibula free flap, large soft tissue defects can be repaired with a second flap, either an RFFF or a pectoralis myocutaneous flap. After free fibula harvest, most patients will have some decrease in their range of motion of ankle plantar flexion and dorsiflexion and loss of knee and ankle strength. However, as demonstrated by Anthony and coworkers, these decreases are not severe enough to have an impact on patients’ daily activities.[10]

Iliac Crest

As the popularity of the fibula flap has grown, the indications for use of an iliac crest free flap have decreased. The iliac crest will provide a large segment of corticocancellous bone, up to 14 cm in length, vascularized by the deep circumflex iliac artery and its two venae comitantes.[11] The deep circumflex iliac vessels can be dissected to their origin from the external iliac vessels to provide a pedicle length between 8 and 10 cm. The height of the native mandible can be matched by harvesting an appropriate amount of bone from the iliac crest (Fig. 81-6). Depending on the location of the mandibular defect, preoperative planning with models of the mandible and iliac crest will help the surgeon pattern the segment of the iliac crest bone on the ipsilateral or contralateral iliac crest to use the normal curve of the superior iliac crest. Cutaneous perforators along the medial aspect of the iliac crest supply an area of overlying skin that can be harvested with the bone as an osteocutaneous flap. To preserve these cutaneous perforators, a cuff of external oblique muscle, internal oblique muscle, and transversus abdominis muscle through which the perforators traverse should be harvested. The thickness of the overlying subcutaneous tissue can make an osteocutaneous iliac crest flap too bulky for intraoral use. To decrease the bulkiness, one can harvest the iliac crest bone with a paddle of internal oblique muscle (supplied by the ascending branch of the deep circumflex artery), which is then skin-grafted.

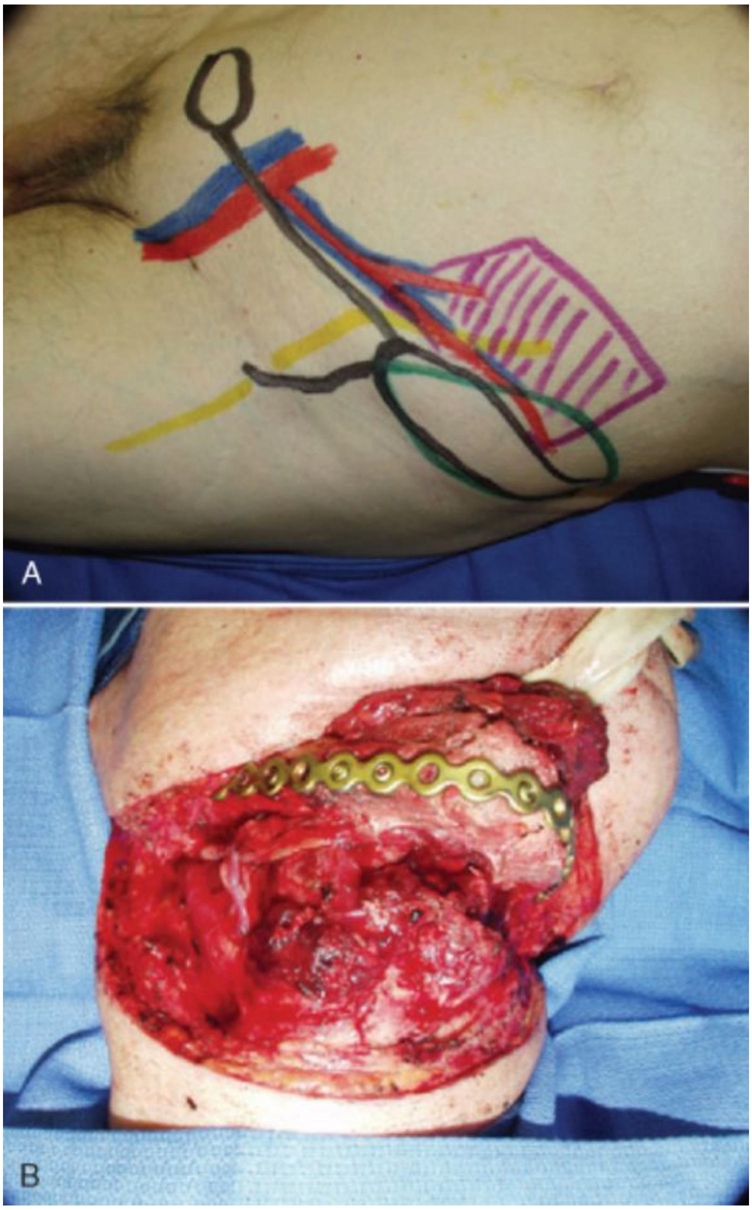

Figure 81-6 Iliac crest—internal oblique free flap. **A,** Flap design with the expected internal oblique muscle harvest indicated in purple. **B,** Iliac crest inset for restoration of an anterior mandibular defect.

Femoral nerve injury, hernia, gait disturbance, and pain are potential donor site morbidities. Harvest of the internal oblique muscle can also cause denervation of the rectus abdominis through interruption of its motor nerve supply, which runs between the internal oblique and transversus abdominis. Forrest and coauthors reported on donor site complications in 82 patients who underwent transfer of a free iliac crest flap.[12] Sensory disturbances (27%), contour irregularity (20%), poor scar (12%), hernia (10%), gait disturbance (11%), and pain lasting longer than 1 year (8%) were documented.

Jejunal Free Flap

The jejunal free flap was the first free tissue transfer reported in the literature in 1959. Its continued use for circumferential pharyngeal defects is a testimony to its time-tested importance in head and neck reconstruction. This flap can be used as a mucosal tube or as a patch. Its advantages for pharyngeal reconstruction include a diameter that matches that of the cervical esophagus, the potential for peristalsis, and innate secretory ability. Large series report success rates higher than 90% with fistula rates between 15% and 20%.[13] The jejunum can now be harvested laparoscopi-cally, thereby reducing much of the postoperative convalescence.[14]

Some of the relative disadvantages of this flap include abdominal complication rates as high as 5.8%.[15] Tracheoesophageal puncture (TEP) speech may be less discernible than that with other flaps because of the intrinsic moistness of the jejunum. The serosa of the flap may also impede neovascularization, which may place the flap in jeopardy if the pedicle is divided during subsequent head and neck surgery. In addition, the plicae circularis of the jejunum may trap food and cause significant halitosis.

Flap harvest is usually performed by qualified general surgeons and may be done simultaneously with the extirpative procedure. Preoperative bowel preparation is not essential. The jejunal arteries arise from the superior mesenteric artery and form a series of vascular arcades that run in the mesentery. Large segments of jejunum can be harvested by proximally dividing a single jejunal vessel that feeds multiple arcades.

To limit ischemia to the jejunum, one should divide the pedicle only after the pharyngeal defect and recipient vessels have been prepared. During inset, if there is a size mismatch at the level of the base of tongue, the antimesenteric border may be divided to “open” up the proximal end. Any redundancy in the jejunum after inset may cause the jejunum to fold on itself and become a barrier to food transport. To prevent such redundancy, we perform the base of the tongue inset first and then the vascular microanastomosis. With perfusion re-established the jejunum expands, and after this expansion we resect any redundant jejunum before completing the mucosal anastomosis to the cervical esophagus. A jejunal feeding tube is usually placed because long-term supplementation may be required even after oral intake of food has begun.

Anterolateral Thigh Flap

The anterolateral thigh free flap has recently gained popularity in soft tissue reconstruction of the head and neck.[16] It is a perforator flap derived from the descending branch of the lateral circumflex femoral artery. Its advantages include a long pedicle with a suitable vessel diameter and the possibility of harvesting the flap with thigh musculature (the vastus lateralis, rectus femoris, tensor fasciae lata, or any combination of these muscles) or as a sensate flap (by incorporating the anterior branch of the lateral cutaneous nerve of the thigh). Because of its distance from the head and neck, harvest can be performed simultaneously with tumor extirpation.

Flap elevation begins by mapping the cutaneous perforators with a pencil Doppler probe. These perforators are located by first marking the midpoint between the anterior superior iliac spine and the superolateral corner of the patella (Fig. 81-7A and B). A circle centered at this midpoint is then drawn with a radius of 3 cm. The majority of the cutaneous perforators are located in the inferolateral quadrant of this circle. The flap is then harvested with its center over these perforators and its long axis parallel to that of the thigh. The flap can be elevated with or without the fascia lata (suprafascial dissection). The skin and subcutaneous tissue of the flap are raised until the perforator or perforators to the skin are defined. Once the skin vessel or vessels are seen, they are dissected until the main pedicle is reached (Fig. 81-7C). If the skin vessel is a musculocutaneous perforator (the majority of patients), harvest includes intramuscular dissection through the vastus lateralis muscle. If the skin vessel is a septocutaneous perforator, the dissection is simpler and proceeds between the vastus lateralis and rectus femoris muscles.[16] The length of the pedicle is 8 to 16 cm, with a vessel diameter larger than 2 mm.

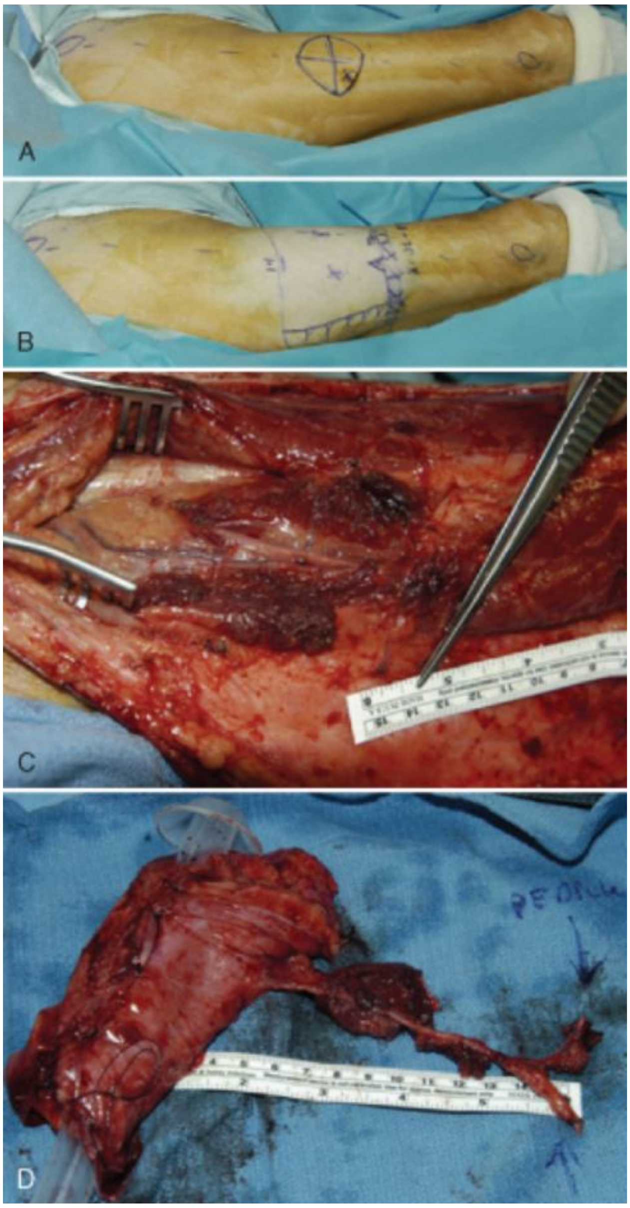

Figure 81-7 Anterior lateral thigh flap (ALTF). **A,** *Circle* marking the location of the cutaneous perforator. **B,** Flap design based on the location of the perforator. **C,** A single musculocutaneous perforator supplies the entire flap. **D,** Total pharyngeal reconstruction using the ALTF. The fascia lata has been wrapped around the reconstruction for an additional layer of closure.

A skin defect of less than 9 cm in width can be closed primarily without any reported evidence of compartment syndrome. Larger defects require skin grafting. A distinct disadvantage is the thickness of the flap in overweight individuals. However, the flap can be trimmed to the subdermal fat level for use as a thinner flap (4 mm). In subfascial dissections, loss of the fascia lata may leave a bulge in the lateral aspect of the thigh. The vastus lateralis muscle is a major constituent of the quadriceps femoris. However, in cases in which the vastus lateralis has been taken for reconstructive purposes, nearly normal quadriceps function has been reported.[17]

SURGICAL APPROACHES

Mandibular Defects

The indications for mandibular reconstruction remain a subject of legitimate controversy. The fact that major mandibular resection carries with it significant functional and cosmetic sequelae is undisputed, but the effect of mandibular resection on function is highly variable. The level of postoperative disability depends on (1) the preoperative condition of the oral cavity (including the presence or absence of viable teeth), (2) the extent of mandible to be included in the resection, (3) the site of the tumor (anterior versus lateral), and (4) the soft tissues to be resected. When the mandible is resected with an accompanying large soft tissue defect, the mandibular defect is sometimes “incidental” to the rest of the wound. Closure of the soft tissue defect with restoration of function and coverage of the planned mandibular reconstruction becomes the primary goal.

The extent of mandibular resection is critical in predicting the disability secondary to surgery. Some patients function well after segmental lateral mandibulectomy without restoration of mandibular continuity. However, a contour deformity of the lower third of the face will develop in patients whose defects have not been reconstructed, and the pull of the contralateral muscles of mastication displaces the remaining mandible toward the side of the defect. In patients with dentition this results in malocclusion. For these reasons, most surgeons offer patients primary reconstruction of lateral mandibular defects.

Numerous reports have supported the use of a reconstruction plate with soft tissue coverage to reconstruct pure lateral mandibular defects (see Fig. 81-2). Soft tissue coverage has generally been provided by a pectoralis myocutaneous flap or an RFFF. Delayed reconstructive failure secondary to external plate exposure or plate fracture has generally been reported to occur in 5% to 7% of cases. For lateral mandibular defects, Shpitzer and colleagues advocate the use of an osteocutaneous free flap.[18] In their report comparing three different reconstruction techniques for lateral mandibular defects (plate and pectoralis major myocutaneous flap [PMMF], plate and RFFF, and osteocutaneous flap), plates had to be removed in 7 of the 27 patients in the PMMF group and 2 of the 16 patients in the RFFF group. None of the 14 osteocutaneous free flaps failed. Speech was also best in the osteocutaneous free flap group.

Anterior mandibular resection can leave a patient an oral cripple. When reconstruction is not attempted, the retained segments of the mandible tend to collapse toward the midline. This lack of support results in an Andy Gump deformity with associated oral incontinence and cosmetic deformity. Schusterman and associates, in a study of the use of AO plates for immediate mandibular reconstruction, noted an unacceptably high rate of plate failure in patients with anterior defects.[19] Plate extrusion developed in four of the six patients (66%) who underwent reconstruction of anterior defects with a plate and soft tissue flap. Free tissue transfer of a composite osteocutaneous flap was thus advocated as the reconstructive method of choice. However, all centers do not report such a high rate of anterior plate failure. In an evaluation of 51 cases of primary mandibular reconstruction with the titanium hollow-screw reconstruction plate, Irish and coauthors reported a 19% incidence of plate failure in patients with anterior defects and a 13% incidence of failure with lateral defects.[20] In their experience with 102 stainless steel and titanium bridging plates, the success rate was 83% for lateral defects and 65% for anterior defects at 2-year follow-up.[21]

Given the long-term problems of plate fracture and exposure, we prefer to perform free vascularized bony reconstruction for both lateral defects and anterior defects (see Figs. 81-1 and 81-5). In patients who are unwilling or unable to undergo free vascularized bone transfer becomes of significant comorbidity, poor prognosis, or lack of recipient vessels, we perform a plate and soft tissue flap reconstruction. If the goal of reconstruction with a pectoralis flap is simply to close the wound and allow a patient to avoid complications, one should consider using a pectoralis flap only for soft tissue reconstruction without restoration of mandibular continuity with a reconstruction plate.[22]

Glossectomy Defects

Restoration of tongue function after ablative surgery remains a major challenge for the reconstructive surgeon. The ultimate goal is to restore form and function, but the complex set of intrinsic and extrinsic muscles that provide coordinated motor activity cannot be duplicated by reinnervated muscle flaps. It is unrealistic to expect a unidirectional, reinnervated muscle, such as the rectus abdominis, to mimic the complex pattern of muscle contraction in the native tongue. The attainable goals of tongue reconstruction are preservation of the mobility of the remaining tongue, restoration of bulk so that the neotongue can contact the palate to assist in articulation and swallowing, and restoration of sensation.

The extent of the glossectomy and the presence or absence of an associated mandibulectomy defect determine one's approach to reconstruction.[23] Because of the different functions of the two regions, the tongue is divided into the mobile anterior part and the tongue base. The mobility of the anterior tongue is critical for articulation, mastication, and the oral phase of swallowing. The tongue base is critical in completing the pharyngeal phase of swallowing. The approach to reconstructing the mobile tongue should involve the use of thin, sensate, pliable tissues that maintain maximum mobility and potentially restore sensation. Defects of the tongue base present a separate problem. The volume of the tongue base must be restored so that it can contact the pharyngeal walls and generate force to drive the food bolus through the pharynx.

The combination of a segmental mandibulectomy defect and a partial glossectomy defect involving the mobile tongue or both the mobile tongue and base of tongue is a more challenging reconstruction. The reconstructive options begin with first choosing the optimal flap for tongue reconstruction and then considering the options for the mandible. Two free flaps, in particular, a forearm flap with a fibular flap, may be necessary for complex composite defects. For segmental defects less than 8 cm and with significant tongue defects, an osteocutaneous RFFF is often our first choice. Lateral composite mandibular defects may be reconstructed with a fasciocutaneous free flap or a pedicled flap and a mandibular reconstruction plate. Soft tissue reconstruction without restoration of lateral mandibular continuity can also yield satisfactory outcomes.

Total tongue reconstruction involves creating bulk for the neotongue and positioning the neotongue so that its vertical height is sufficient to achieve contact with the palate. Free musculocutaneous flaps, in particular, the rectus abdominis free flap, have the advantage that the muscle of the flap can be used as a platform for positioning the overlying fat and skin components. Drill holes placed in the mandible can be used to secure the muscle. The tendinous inscriptions in the rectus abdominis flap offer better purchase for sutures than do those directly placed in muscle. Fasciocutaneous free flaps, such as forearm, scapular, parascapular, or anterolateral thigh, can also be de-epithelialized and folded on themselves to create additional bulk and help maintain the position of the neotongue. Total tongue defects can also be reconstructed with a pectoralis major myocutaneous flap (see Fig. 81-5C and D). Because of its bulk, an iliac crest osteocutaneous flap should be considered for reconstruction of total glossectomy defects with anterior mandibular defects.

Pharyngectomy Defect

The major goal of pharyngeal reconstruction is restoration of swallowing. Laryngeal preservation in the setting of a major pharyngeal defect is especially challenging because aspiration is inevitable. In addition to the patient's preoperative function, designing a reconstruction that can minimize aspiration may be the critical issue that determines whether patients will be able to keep their larynx. It is important to choose a flap that can be inset at the level of the hypopharynx both to prevent stenosis and to not be too bulky and cause obstruction. Although the pectoralis major flap has been used with success, the radial forearm flap offers many advantages.[24] Its pliability allows exact replacement of the hypopharyngeal mucosa. In addition, with a radial forearm flap a nonvascularized rib graft can be used to reconstruct the infrastructure of the larynx.[25] Anastomosis of an antebrachial cutaneous nerve of the forearm flap with the superior laryngeal nerve may assist the neopharynx in regaining sensation.

In most cases of advanced laryngopharyngeal or pharyngeal carcinoma the larynx is resected. When a strip of hypopharyngeal mucosa remains after total laryngopharyngectomy, controversy exists concerning the relative benefits of resecting the remaining mucosa and converting the defect to a circumferential defect. Preservation of the remaining mucosa and incorporation of this mucosa into the reconstruction may reduce the risk of stenosis. However, the additional suture lines may place the reconstruction at greater risk for a fistula than is the case with a tubed free flap.

For circumferential defects the jejunal free flap has been the “gold standard.”[26] It requires no tubing and thus one less suture line. Most studies report that the jejunal free flap has stenosis and fistula rates that are lower than or equal to those of tubed fasciocutaneous flaps.[27] The major alternative to the jejunum is a tubed RFFF (Fig. 81-8). Its advantages over the jejunum include the lack of abdominal harvest, better TEP speech, and the ability to create separate skin paddles for cervical skin reconstruction.[27] The use of a Montgomery stent may lower fistula and stenosis rates.[28] The anterolateral thigh free flap may also be used for pharyngeal reconstruction and has the additional advantage that the fascia lata may be included to provide an extra layer of closure for the neopharynx (see Fig. 81-7D). Studies are ongoing to determine the effectiveness of this reconstruction.[29]

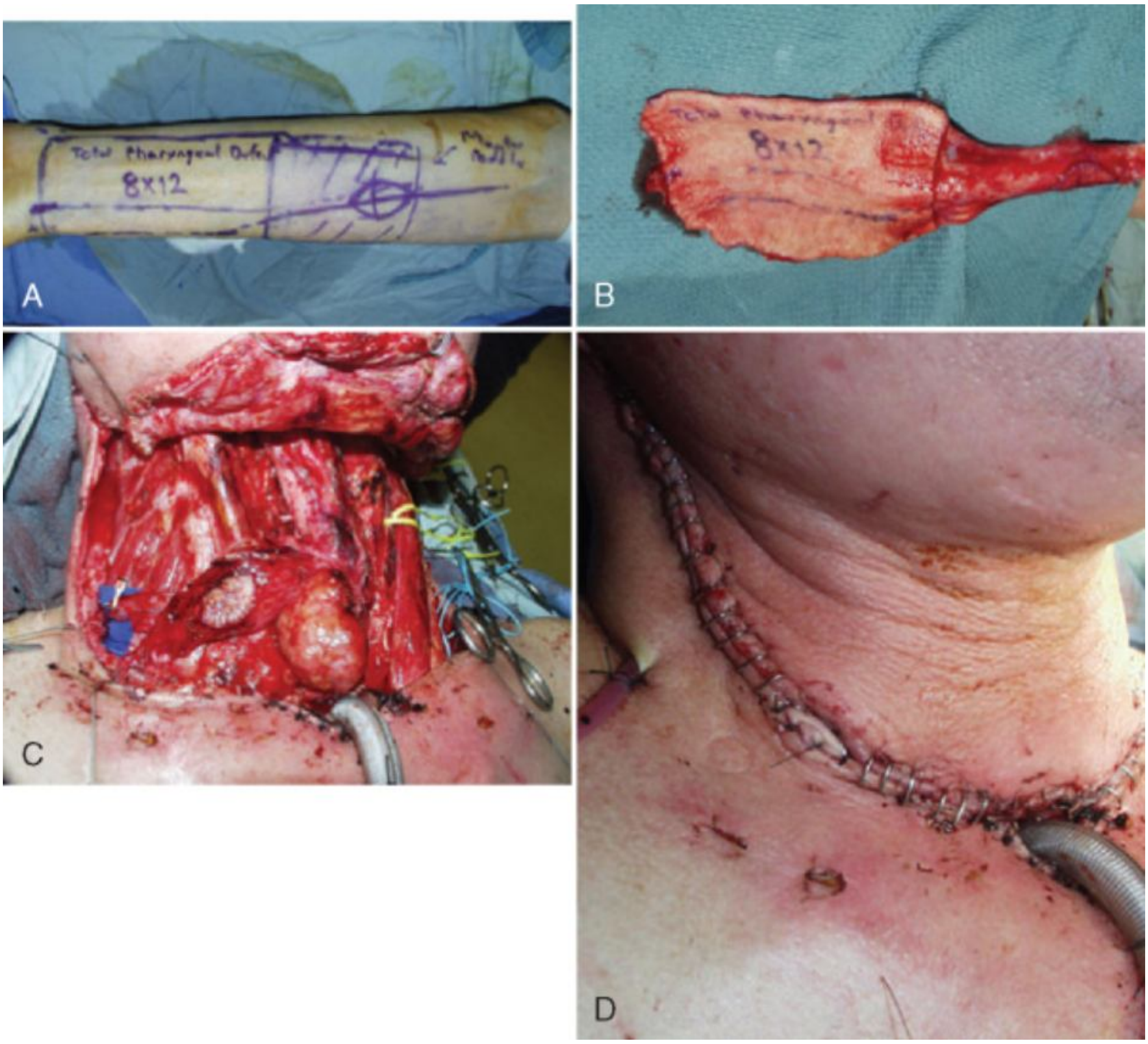

Figure 81-8 Total pharyngeal reconstruction with a radial forearm fasciocutaneous free flap (RFFF) harvested with a monitor paddle. **A,** Flap design with a monitor paddle. **B,** The RFFF tubed for circumferential pharyngeal reconstruction. The monitor paddle is connected to the tubed skin paddle with subcutaneous tissue. **C,** Anastomosis to the right transverse cervical artery and vein. **D,** Monitor paddle inset within the cervical incision.

If the cervical esophageal resection extends below the thoracic inlet, most reconstructive surgeons would not place a reconstructive suture line within the chest because of the increased morbidity of a salivary leak. Gastric pull-up continues to be the gold standard for defects that extend below the thoracic inlet.

Midface and Maxillectomy Defects

Defects in the midface occur after resection of tumors that arise from the paranasal sinuses, palate, overlying skin, nasal cavity, skull base, orbital contents, or oral mucosa. As a result, extensive midface reconstructions may require independently reconstructing the palate, orbit, cheek, and bony midface (maxilla and zygoma).

Recently, Cordeiro and Santamaria proposed a classification system and algorithm for reconstruction of maxillectomy and midfacial structures.[30] The temporalis muscle, soft tissue free flaps (rectus abdominis and radial forearm), nonvascularized bone (rib or calvaria), and vascularized bone flaps (osteocutaneous RFFF) were used to construct a variety of maxillectomy defects. Palatal defects were closed only with soft tissue (see Fig. 81-4). The nonvascularized and vascularized bone was used for osseous reconstruction of the zygoma, maxilla, and orbital floor.

Other algorithms containing many other free flaps and designs have been adopted.[31] Many have focused on various osteocutaneous flaps such as the fibula and the iliac crest. These latter flaps allow osteointegration of implants for dental rehabilitation.[32] In cases of combined midface and lip resection, oral competency can be restored by using local flaps, such as the Abbé lip switch flap, in combination with free tissue transfer.

Skull Base Defects

Although small defects can and should be reconstructed with local flaps, such as pericranial or temporoparietal fascial flaps, many defects in the expanding spectrum of extirpative endeavors will require free tissue transfer.[33] The main reconstructive needs of skull base defects include separating the intracranial and extracranial spaces to avoid intracranial infections, obliterating the dead space with coverage of vital structures, preventing brain herniation, diminishing the risk of cerebrospinal fluid leakage, and restoring cosmesis. The rectus and latissimus myocutaneous (or myofascial) free flaps (Fig. 81-9) are two of the flaps commonly chosen.[34] The rich vascular supply of the flaps' muscle component can allow neovascularization of dural reconstructions and free bone grafts, and their large subcutaneous fat and skin islands can obliterate dead space and be used to reconstruct any skin deficit. In some instances of massive resection, multiple flaps may be needed. In such cases the subscapular artery system allows a combination of flaps based on one pedicle. For example, a latissimus dorsi myocutaneous flap may be harvested with a scapular osteocutaneous or fasciocutaneous flap.[35]

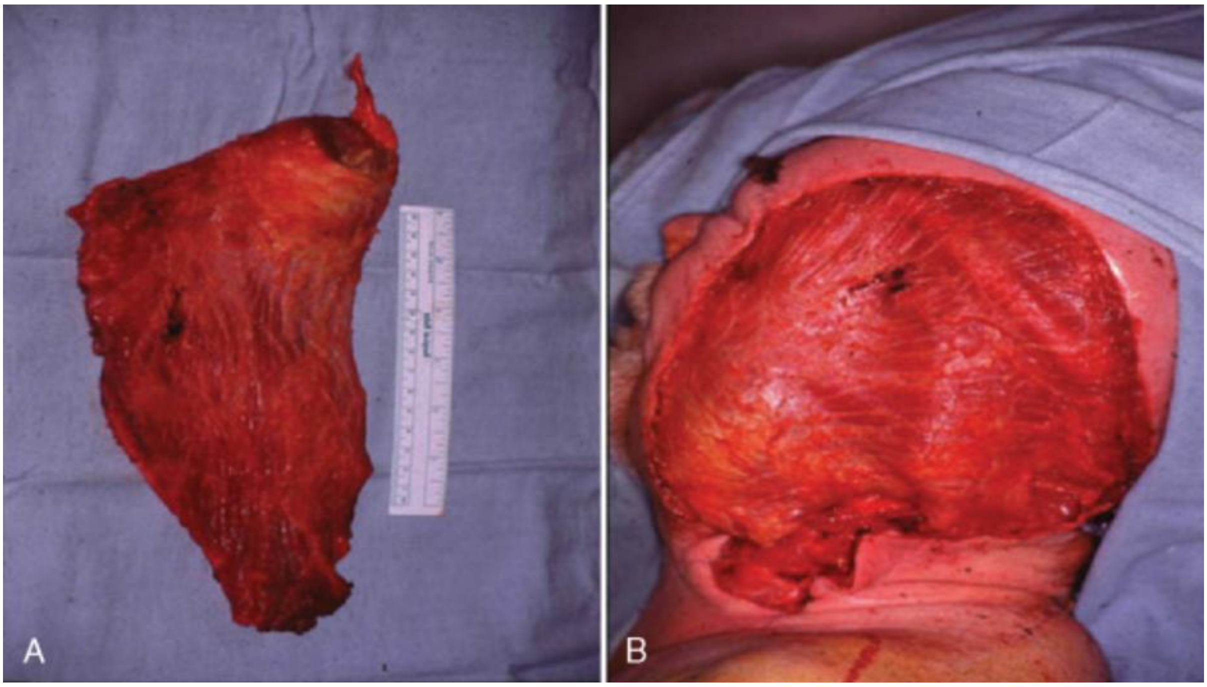

Figure 81-9 Latissimus dorsi free flap. **A,** Muscle harvested. **B,** Reconstruction of the lateral temporal bone resection.

POSTOPERATIVE MANAGEMENT: FREE FLAP MONITORING

The gold standard for assessing the viability of a free tissue transfer remains clinical examination. We prefer nursing assessment of all flaps (with Doppler examination of the pedicle) every hour for the first 72 hours and physician assessment every 6 hours. Color, turgor, temperature, evidence of edema, quantity and quality of blood extravasation after pinprick, and quality of the Doppler sound are all basic methods of assessment. The arterial signal should increase in strength during subsequent postoperative days. The venous signal should be augmentable.

Signs of venous congestion include bluish discoloration, increased warmth and swelling, and quick and bluish blood return after pinprick (Fig. 81-10). The arterial Doppler sound may be "hammer-like," indicative of outflow obstruction, and there may be loss of the venous signal. With arterial compromise the flap appears pale, feels cool, and has a loss or delay of bright red blood with pinprick of the flap. The Doppler sound may be present but can be faint, and areas thought to represent skin perforators may be lost totally, an indication of early loss of vascular inflow. If there is any concern about vascular inflow or outflow obstruction, the patient should be returned to the operating room immediately for surgical exploration.

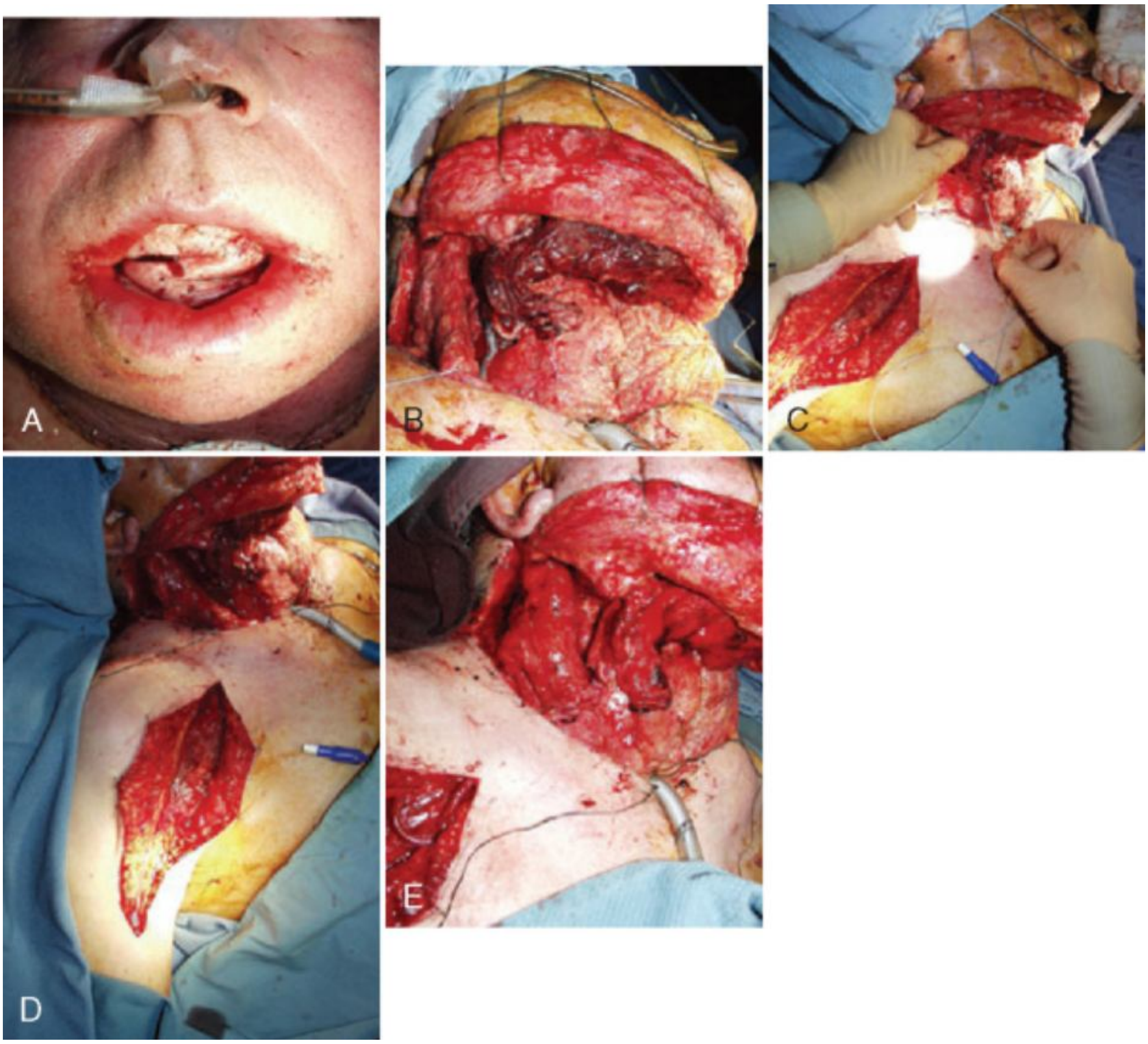

Figure 81-10 Venous outflow obstruction and restoration (postoperative day 1, same patient as in Fig. 81-5). **A,** Venous congestion of a fibular free flap: bluish blood with pinprick of a flap skin paddle. **B,** Saphenous vein graft and internal jugular vein clotted. **C,** Clots in the venae comitantes of the fibular flap cleared with a no. 3 Fogarty catheter. **D,** Cephalic vein rotated from the right upper extremity to the neck. **E,** Restoration of venous outflow with anastomosis of the cephalic vein to the peroneal vena comitans.

Most fasciocutaneous flaps that are buried, such as for pharyngeal defects, can allow a small skin paddle to be separately incorporated into the cervical skin closure. This permits clinical assessment and pinprick examination. Later, as an outpatient under local anesthesia, this skin island can be removed, and the cervical skin suture line can be reapproximated. Because of its vasculature arcade, a small portion of the jejunum can be separated from the rest of the flap and externalized for monitoring (Fig. 81-11). Afterward (approximately 3 to 5 days after surgery), this segment can be removed by ligating the base with a suture. When assessing buried flaps without an externalized portion, one can rely on a Doppler signal that is transmitted through the cervical apron flap. However, such assessment can be inaccurate if one mistakes the carotid artery and internal jugular vein as the vascular supply to the flap. Although we do not routinely use them, implantable Doppler systems are also available for monitoring flaps.[36]

Figure 81-11 Monitor loop of a jejunal free flap used for pharyngeal reconstruction.

PEARLS

- Any redundancy in the jejunum after inset may cause the jejunum to fold on itself and become a barrier to food transport. To prevent such redundancy, the base of the tongue inset should be performed first and then the vascular microanastomosis. With perfusion re-established, the jejunum expands. After this expansion, any redundant jejunum should be resected before completing the mucosal anastomosis to the cervical esophagus.
- For flaps that are buried, such as the radial forearm fasciocutaneous free flap for pharyngeal defects, a small skin paddle can be separately incorporated in the cervical skin closure to allow clinical assessment and pinprick examination.
- For maxillectomy and midface defects, volume and surface area requirements will dictate whether a rectus free flap or a radial forearm free flap should be selected. Relatively large-volume defects (e.g., total maxillectomy) are commonly reconstructed with a rectus free flap with separate skin paddles designed for reconstruction of the palate and skin.
- Through-and-through composite segmental defects of the mandible can often be reconstructed with a single osteocutaneous radial forearm free flap or fibular free flap. A large skin paddle should be harvested with the flap so that an area of skin can be de-epithelialized to create two skin paddles—one for oral cavity reconstruction and the other for cutaneous reconstruction.
- If there are no recipient veins in the neck for microanastomosis, the cephalic vein can be transected distally in the arm and rotated to the head and neck for microanastomosis.

PITFALLS

- The pedicle length of a rectus abdominis flap may be insufficient to reach the neck, especially when the mandible is intact. Careful planning of the skin paddle and intramuscular dissection of the pedicle from the rectus muscle may be necessary to ensure adequate length.
- Aggressive harvest (>40%) of the radial bone may lead to pathologic fracture of the radius. Prophylactic plating of the radius should be considered to prevent fracture.
- Irreversible ischemic changes in the jejunum can occur within 2 hours. The jejunal vessels should be divided and transferred from the abdomen only after the recipient vessels have been isolated for microanastomosis.
- Failure to recognize venous congestion will lead to total loss of the flap. Leeches should be used only as treatment of venous congestion after problems with the microanastomosis and pedicle have been excluded by surgical exploration.
- Harvest of a fibular free flap in patients with peripheral vascular disease (an ankle-arm index <1.0) but with three-vessel runoff may still lead to delayed wound healing at the harvest site and failure of complete take of a skin graft on the lower extremity cutaneous defect.