

1 Preoperative Considerations in Head and Neck Reconstruction

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Summary

Preoperative planning is critical for success in microvascular free flap surgery, especially in head and neck reconstruction. Patients may have risk factors for free flap loss or other complications such as delayed wound healing and fistula formation. Flap selection is based on many factors including the specific needs of the defect, donor site morbidity, and surgeon preference. Recipient vessel selection can be especially challenging in the previously operated and/or irradiated neck. All reconstructive plans should be made anticipating the possibility of a future free flap for recurrent or second primary cancer as well as osteoradionecrosis, fistula formation, stricture, or aesthetic deformity.

Keywords: preoperative, head and neck reconstruction, free flap, hypercoagulable, recipient blood vessel, CT angiography

1.1 Introduction

The reconstructive process starts with the initial consult. Patients need to be evaluated for their suitability for surgery, counseled so that they have realistic expectations for postoperative function and appearance, and provided with a plan for surgery. No single flap or technique is necessarily appropriate for any given defect. Flap choice will depend on patient anatomy, the specific needs of the patient, and surgeon preference. It is also during the preoperative work-up that potential complications begin to be anticipated.

1.2 Preoperative Evaluation

All patients need to be assessed for the ability to tolerate surgery involving both oncologic resection and reconstruction, whether with pedicled or microvascular free flap reconstruction. Age alone has not been shown to be a contraindication to complex and potentially extensive surgeries, such as free flap reconstruction.¹ However, comorbidities that are frequently found in older patients, such as coronary artery disease, cerebrovascular disease, pulmonary disease, and peripheral vascular disease, may be. Risk factors for wound-healing complications and infection should also be considered, such as poor nutritional status, diabetes mellitus, tobacco use, prior radiation and surgery, and corticosteroid use. Whenever possible, steps are taken to correct or optimize the patient's medical condition prior to surgery; however, such interventions must be weighed against the risk of disease progression. In the case of malignant disease, relatively high-risk surgery is often warranted when the potential benefits of cancer cure, alleviation of pain, and functional preservation or restoration outweigh the risks of complications.

Specific to free flap surgery, patients should be questioned about prior free flap loss and thromboembolic events, including

deep vein thrombosis, pulmonary embolus, and spontaneous miscarriage. A history of any of these conditions should prompt consideration for further work-up by a hematologist to identify a possible hypercoagulable condition, such as factor V Leiden mutation, anticardiolipin antibodies, or protein C deficiency. The presence of a hypercoagulable condition may be the basis for avoiding microvascular free flap surgery or implementing additional chemoprophylaxis, such as with aspirin or heparin products during the perioperative period. Prior case series have shown that microvascular free flap surgeries can be successful in patients with various hypercoagulability disorders, although with somewhat higher risk for flap loss.² Patients should be counseled regarding elevated risks for flap loss and the need for anticoagulation as well as the risk of additional surgery for flap salvage or secondary reconstruction in the setting of flap failure.

Depending on the site of the cancer and the expected extent of the resection, the patient should be counseled regarding the expectations for functional and aesthetic outcomes following reconstructive surgery. Preoperative function should be noted since prior dysfunction may worsen the prognosis for functional restoration. For oral cavity cancers, speech and swallowing are evaluated, usually in coordination with a speech and language pathologist (i.e., speech therapist). If impaired, a modified barium swallow evaluation may be indicated preoperatively to help give prognostic information regarding the chances of recovery. For maxillary and mandibular surgery, the presence of trismus, pathologic fractures, and malocclusion should be noted as they render reconstruction more challenging.

In patients with parotid or temporal bone tumors, facial nerve function should be assessed. The function of each of the branches of the facial nerve should be documented preoperatively. Nerve repair, nerve transfer (e.g., cranial nerve V to VII or XII to VII nerve transfer), static reanimation (e.g., fascial sling, browlift, upper eyelid gold weight placement, lateral canthoplasty, and tarsorrhaphy), and, in some circumstances, dynamic reanimation with a motorized muscle free flap should be discussed as possible interventions. Nerve repair and nerve transfer as well as fascial slings are usually performed immediately after resection, while periocular procedures and dynamic reanimation can be performed immediately or in a delayed manner, depending on the circumstances as well as patient and surgeon preferences.

In patients who have had prior irradiation, neck dissection, and/or free flap surgery, commonly used recipient blood vessels, such as the branches of the external carotid artery and the internal or external jugular vein, may not be available. In such patients, imaging studies of the neck (see below) may be useful. When these recipient blood vessels are not available, the use of other regional blood vessels should be considered, and the patient should be informed about the possibility of additional incisions for exposure and potential need for vein grafts. In patients who are undergoing laryngectomy, cervical lymphadenectomy,

or other procedures requiring wide neck incisions, the quality of the neck skin also needs to be assessed. In irradiated patients, the neck may not close primarily and a pedicled or free flap may be needed for closure in addition to reconstruction of the primary cancer site (see Case 1). Other considerations include the potential need for tracheostomy due to temporary or permanent airway compromise and need for nasogastric or gastrostomy feeding tube placement while mucosal wounds heal or to prevent temporary or permanent pulmonary aspiration of foods and liquids.

Case 1: Hypopharyngeal Reconstruction with Neck Skin Defect

A patient with recurrent laryngeal cancer following combined radiation and chemotherapy presents for salvage oncologic resection. A circumferential hypopharyngeal resection is performed in concert with total laryngectomy (► Fig. 1.1). Although no skin was resected with the laryngopharyngectomy,

it was evident following the resection that the radiated anterior neck skin could not be reclosed primarily without substantial tension, creating a risk for wound dehiscence with vascular exposure and possible fistula formation. Therefore, a flap was needed for neck skin reconstruction in addition to a flap for pharyngeal reconstruction. An anterolateral thigh (ALT) free flap was planned for pharyngeal reconstruction. Fortunately, two cutaneous perforators were discovered upon exploration of the thigh, allowing for two independent skin paddles so that both defects could be reconstructed with a single flap. Alternatives included a second free flap, a pectoralis major pedicled flap (myocutaneous or muscle covered by skin graft), or use of the vastus lateralis muscle covered by a skin graft harvested with the ALT skin paddle used for pharyngeal reconstruction. The need for neck skin reconstruction was anticipated preoperatively and the patient was appropriately counseled regarding the possibility of performing one or more of these surgical options.

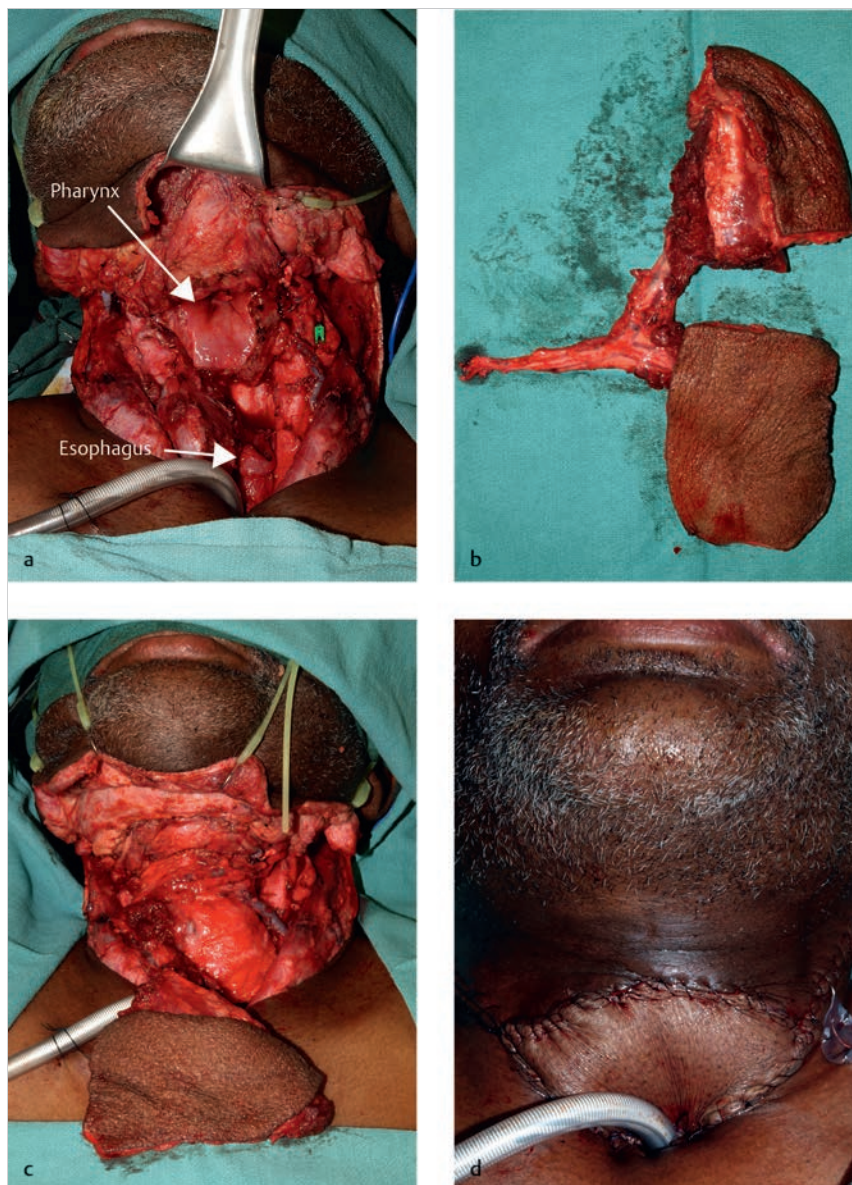


Fig. 1.1 (a) A laryngopharyngectomy is performed in a patient with recurrent laryngeal cancer following treatment with radiation and chemotherapy. (b) An anterolateral thigh (ALT) free flap is harvested with two skin paddles based on separate cutaneous perforators. (c) One skin paddle is used to reconstruct the pharyngeal defect and the other is used to reconstruct the neck skin. (d) Although no neck skin was resected, the skin could not be closed without suturing under significant tension, resulting in a high risk for wound dehiscence.

1.3 Imaging Studies

Recent head and neck imaging is mandatory for planning not only the resection but also the reconstruction. Computed tomography (CT) or magnetic resonance imaging (MRI) will help predict the extent of the extirpative defect, which, in turn, will help the reconstructive surgeon anticipate the structural, functional, and aesthetic challenges of reconstruction. CT is generally preferred for assessing cortical bony invasion, which is critical in planning reconstruction of the mandible, maxilla, orbit, and calvarium as it predicts whether bone will need to be reconstructed. For the mandible and maxilla, this usually mandates an osseous or osteocutaneous free flap in the cancer patient, who is expected to receive adjuvant radiation due to invasion. For the orbit, this anticipates the need for titanium mesh, bone graft, or, occasionally, bony free flap reconstruction. For the calvarium, this anticipates the need for bone graft or alloplastic cranioplasty (e.g., titanium mesh or methymethacrylate). Fine-cut CT data can also be used for computer planning and creation of three-dimensional medical models or custom-made implants. In other cases, preoperative imaging can help identify those cases where the facial nerve or other cranial nerves may be sacrificed, and the appropriate discussion regarding procedures to address the functional deficit can be had. For laryngeal cancers, preoperative imaging can anticipate the need for circumferential versus partial pharyngeal defects.

A neck CT with intravenous contrast may also be helpful in identifying potential recipient blood vessels, such as the external carotid artery and its branches as well as the internal and external jugular veins. The transverse cervical blood vessels may also be identified on CT scan. A more specific CT angiography (CTA) may be indicated in the vessel-depleted neck as well as in patients with carotid vascular disease as part of perioperative medical clearance for surgery.

When a fibula free flap is planned, CTA may be useful not only for confirming three-vessel outflow to the leg and foot, but also to map cutaneous perforators to the skin around which flap skin paddles can be designed (► Fig. 1.2).³ CTA of the abdomen and thighs is used by some surgeons to evaluate the presence and course of perforators for deep inferior epigastric perforator flaps and ALT free flaps, respectively. CTA has been shown to be fairly accurate for perforator mapping, usually localizing perforators to within 1 to 2 cm from the location from which they pierce the deep fascia.

1.4 Flap Selection

While specific flap selection for each type of head and neck reconstruction is beyond the scope of this chapter, some general principles apply to all defects. The main requirement is to replace bony structures, which play a role in facial shape and function, with bony free flaps or, for small defects, bone grafts or alloplasts covered with well-vascularized tissues, such as soft tissue pedicled and free flaps. For other defects, including some bony defects, such as the posterior mandible or maxilla, the skull base, temporal bone, or even limited calvarial defects, soft tissue flaps are used because they are usually more straightforward and have lower donor site



Fig. 1.2 (a) A computed tomography angiography (CTA) of the lower extremities demonstrating three-vessel outflow to the legs and feet. (b) Cutaneous perforators, such as the one indicated by the arrow, can be visualized on CTA and help with planning where to design the fibula osteocutaneous free flap skin paddle.

morbidity. The fibula osteocutaneous free flap is often the preferred flap for bony head and neck reconstruction, with iliac crest, scapular, and radial osteocutaneous free flaps being secondary choices.

For some soft tissue reconstructions, muscle flaps covered by skin grafts or muscle flaps allowed to spontaneously mucosalize may be reasonable options. Such flaps include the rectus abdominis, vastus lateralis, and latissimus dorsi muscle free flaps as well as the temporalis and pectoralis major muscle pedicled flaps. Muscle is well vascularized and is preferred by many surgeons for being able to eliminate dead

space and theoretically help bring excellent blood flow to contaminated or infected tissues. Potential disadvantages of muscle flaps include contracture and atrophy, which are more pronounced in muscle rather than skin and adipose tissues, as well as being less watertight during the initial healing period, thus being possibly more prone to fistulization.

Cutaneous or myocutaneous flaps are often preferred in areas where a watertight seal is critical, such as many oral and pharyngeal reconstructions, as well as cutaneous defects where it is desirable to minimize contracture to prevent distortion of facial structures, such as the nose, lips, and eyelids. Cutaneous and myocutaneous flaps are often selected based on their thickness. Thick flaps are needed for deep defects, while thin, pliable flaps are often preferred for mobile structures such as the eyelids, cheeks, and lips as well as for partial and hemiglossectomy and pharyngoesophageal defects. In Western patients, the rectus abdominis myocutaneous and ALT free flaps are often the preferred choices for thick, bulky flaps, while radial and ulnar forearm fasciocutaneous free flaps are often the preferred choices for thin, pliable flaps.

In extensive defects, particularly those that involve multiple tissue types, such as cheek-mandible-buccal mucosa, mandible-tongue, or maxilla-mandible-buccal mucosa, more than one free flap or a chimeric free flap (single pedicle but multiple flap components, such as the latissimus dorsi-scapular bone-parascapular skin free flap based on the subscapular artery) may be needed to achieve the most optimal results (see Case 2).⁴ Particular scrutiny should be paid to available donor sites and potential recipient blood vessels in these situations. Patients should be warned about extended operative times, although such surgeries can often be accomplished without significantly prolonging the duration of surgery compared with single free flap surgeries with skillful orchestration of the surgery utilizing two or more surgical teams for donor site preparation/cancer resection and flap elevation.⁵

If a forearm-based flap is anticipated, an Allen's test, in which the clinical patency of the radial and ulnar arteries is evaluated, is required. The vessel that is less dominant or does not contribute substantially to distal circulation is usually then selected as a basis for the flap. Alternately, if a dominant vessel does need to be sacrificed, for example, the radial artery for a radial forearm free flap in a situation where a longer pedicle than an ulnar forearm free flap can provide is necessary, vein graft repair of the radial artery should be discussed with the patient if there are signs of insufficient distal perfusion after flap harvest. Also, the patient is asked about which upper extremity is dominant and the nondominant one is usually preferred as the flap site as long as the circulation is equally good between the two upper extremities. If the circulation to the hands is in question after physical exam, preoperative angiography should be obtained.

If a fibula free flap is anticipated, the patient is asked about symptoms of arterial insufficiency, such as claudication. On physical exam, the pedal pulses are palpated and the legs and feet checked to see if they are warm and hair bearing. If

concerns for vascular insufficiency arise, preoperative angiography should be obtained. Severe venous insufficiency may be a contraindication to fibula osteocutaneous free flap harvest due to issues with donor site wound healing. If the circulation to both lower legs is sufficient, the author generally prefers to use the contralateral fibula for mandible reconstruction. Selecting the fibula that is contralateral to the defect orients the pedicle posteriorly toward the recipient vessels and places the skin paddle intraorally. This configuration uses the lateral aspect of the fibula as the plating surface while the pedicle is protected medially, and allows the skin paddle to be oriented superiorly to reconstruct the intraoral mucosal defect. If the skin paddle is needed to reconstruct an external defect or a palatamaxillary defect, then the ipsilateral fibula is usually selected.

Case 2: Double Free Flap Reconstruction for a Mandibulectomy and Through-and-Through Cheek Defect

A patient with a prior history of head and neck cancer treated with radiation presents with osteoradionecrosis of the right mandible complicated by an orocutaneous fistula. A composite resection including oral mucosa, mandible, and cheek skin was performed (► Fig. 1.3). A left fibula osteocutaneous free flap is used to reconstruct the mandible and oral mucosal defect. A lateral thigh incision was made in preparation for an ALT free flap harvest. A lateral cutaneous perforator was not found; however, a medial perforator, penetrating the rectus femoris muscle, was identified. Therefore, an anteromedial thigh (AMT) free flap was harvested and used to close the neck skin defect. The AMT flap was of appropriate thickness for reconstructing the cheek and provided stable coverage of the fibula free flap and titanium hardware. While a pedicled pectoralis major myocutaneous (PMMC) flap could also have been used, such flaps can have problems with contracture along the pedicle, restricting neck movement as well as creating an unappealing bulge in the neck secondary to the bulk of the proximal muscle. When used, the PMMC flap can be harvested as an island flap, minimizing proximal bulk and, if contracture occurs, the pedicle can be divided secondarily several months later.

1.5 Recipient Blood Vessel Selection

The head and neck region is richly vascularized with many anastomotic connections between vascular subunits, providing many options for recipient blood vessels. For most primary oral, mandibular, and pharyngeal reconstructions, the facial or the superior thyroid arteries are most commonly used (► Fig. 1.4). For most scalp, orbital, and maxillary reconstructions, the superficial temporal (► Fig. 1.5) or,



Fig. 1.3 (a) A patient with a history of radiation for head and neck cancer developed osteoradionecrosis (ORN) of the mandible with an orocutaneous fistula, requiring mandibulectomy and excision of both gingival mucosa and cheek skin. (b) A fibula osteocutaneous free flap was performed for mandibular and oral mucosa reconstruction and an anteromedial thigh (AMT) free flap was performed for cheek skin reconstruction. (c) The AMT flap provides wound closure without tension and provides a good contour to the cheek and neck. (d) Postoperative appearance.

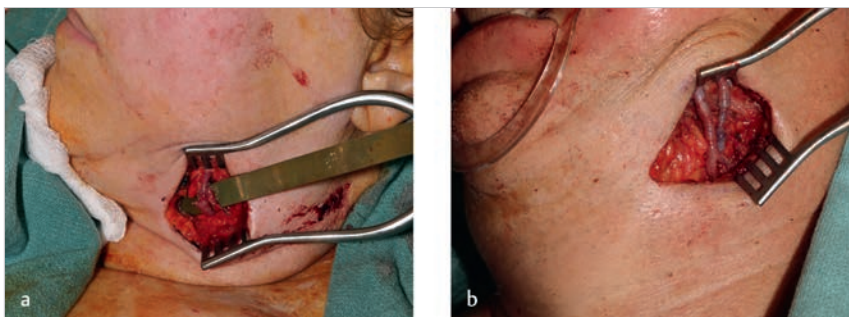


Fig. 1.4 (a) The facial artery and vein can be easily located by making a small transverse incision about 1 to 2 cm below the inferior border of the mandible. The marginal mandibular nerve will be found deep to the platysma, crossing over the facial vein superficially. The artery is usually deep to the vein, arising from deep to the submandibular gland. (b) A subcutaneous tunnel beneath the skin of the cheek is made for the free flap pedicle so that microvascular anastomoses can be performed to the facial blood vessels.

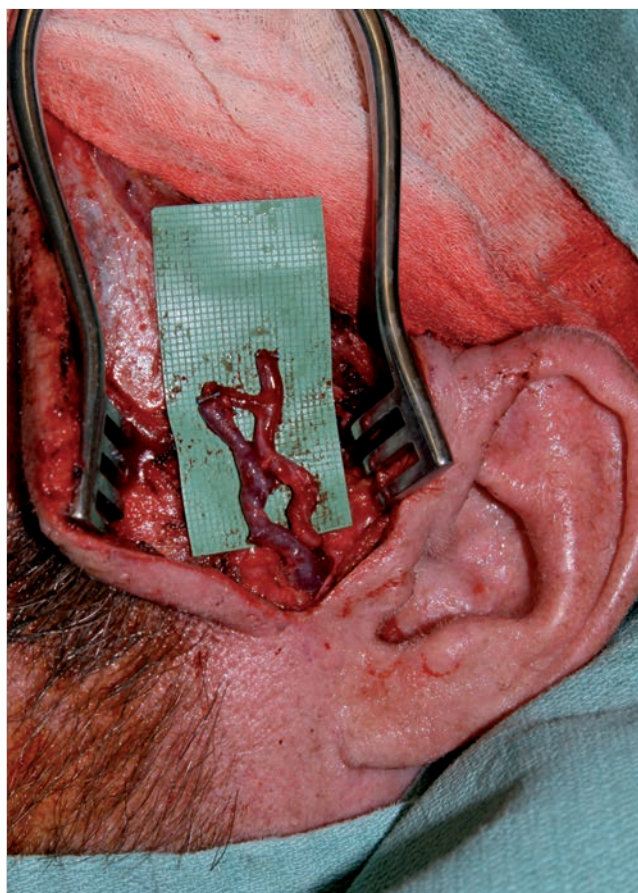


Fig. 1.5 Superficial temporal blood vessels are found by making a preauricular incision. It is often helpful to dissect the vessels proximally, to the level of the tragus in order to obtain a large enough caliber blood vessel for straightforward microvascular anastomosis.

again, the facial arteries are most commonly used (► Fig. 1.6). However, virtually any branch of the external carotid artery may be used. A caveat is that use or ligation of both lingual arteries should be avoided since this may result in tongue necrosis.

When branches of the external carotid artery are not available, the transverse cervical artery can be a good choice (► Fig. 1.7).⁶ This blood vessel is found deep to the posterior belly of the omohyoid muscle, beneath the transverse cervical vein, which can also be useful as a recipient vein, although the external jugular is also in the same region and is usually larger in caliber. For more superiorly based defects, the distance from the flap recipient site to the transverse cervical blood vessels must be compared to use of the contralateral neck blood vessels.

When the transverse cervical blood vessels are not available, then recipient blood vessels outside the head and neck need to be considered as recipient blood vessels.^{7,8} Other sources of regional recipient blood vessels include the internal mammary artery and vein (► Fig. 1.8),⁹ the thoracoacromial artery and vein,¹⁰ and the cephalic vein (► Fig. 1.9).¹¹ Use of these vessels (except for the cephalic vein, which easily reaches the upper neck when divided just above the elbow crease) as well as of contralateral neck vessels usually requires interposition vein grafting. Most recent studies show no differences in flap success rates between those utilizing vein grafts and those that do not. The author recommends use of vein grafts over performing microvascular anastomoses with the pedicle under tension or kinked due to inadequate length. In surgeries involving more than one free flap, one flap pedicle can be anastomosed to a side branch of another flap pedicle, end-to-side of another flap pedicle, or the distal pedicle of another flap (► Fig. 1.10). The author's proposed recipient blood vessel selection algorithm is presented in ► Fig. 1.11.



Fig. 1.6 (a) In this case, a satisfactory superficial temporal artery could not be located for a latissimus dorsi muscle free flap used for scalp reconstruction. The flap artery was anastomosed via a vein graft to the facial artery. (b) Completed reconstruction with the vein graft traveling beneath the widely undermined cheek skin.

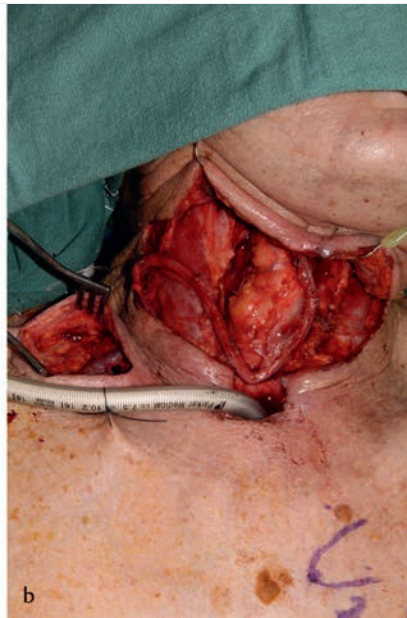
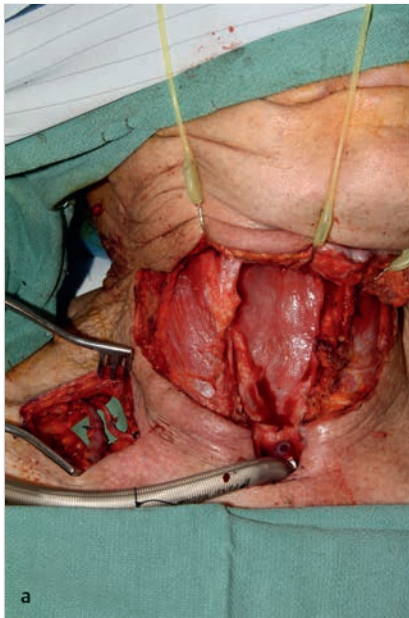


Fig. 1.7 (a) The transverse cervical artery and vein are found about 1 to 2 cm above the clavicle, deep to the posterior belly of the omohyoid muscle. The blood vessels travel from medial to lateral. (b) Example of a radial forearm free flap used for hypopharyngeal reconstruction whose pedicle was anastomosed to the right transverse cervical artery and vein.

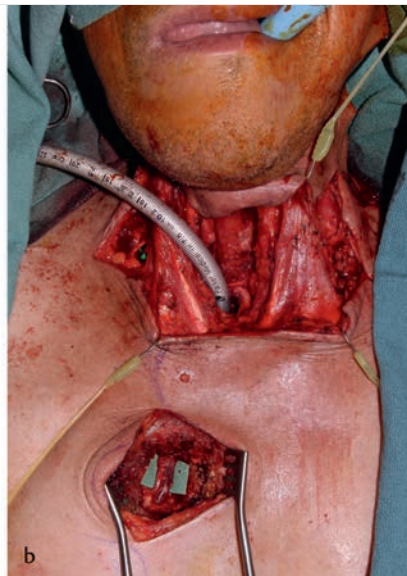
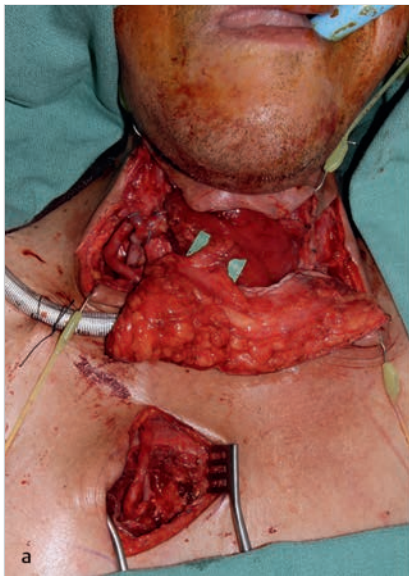


Fig. 1.8 (a) The right internal mammary artery and vein are exposed by removal of the second costal cartilage. (b) A vein graft was needed to connect the internal mammary artery to this double paddled anterolateral thigh (ALT) free flap artery, used to reconstruct the hypopharynx and anterior neck skin.

1.6 Anticipating Secondary Surgery

Aside from surgery for complications, additional surgery may be required to optimize the reconstructive outcomes, and patients should be warned of this possibility preoperatively. For instance, even with intraoperative flap thinning, some flaps will remain too bulky for optimal contour and can benefit from secondary suction lipectomy or direct excision of fatty

tissue and redundant skin. Conversely, autologous fat grafting can be a useful adjunct to fill in concavities that develop secondary to resolution of edema or to flap atrophy that may occur unpredictably. On occasion, some flaps may atrophy or contract so much that an additional flap may be indicated, especially in irradiated patients.

Another very important adjunct to flap reconstruction is dental restoration. In many ways, reconstruction is not complete unless the dentition can be satisfactorily restored. For limited defects in patients with stable adjacent teeth, a dental prosthesis



Fig. 1.9 Left cephalic vein transposition for use as a recipient vein. The vein empties into the axillary vein within the deltopectoral groove.



Fig. 1.10 Double free flap reconstruction with fibula osteocutaneous free flap and two-skin paddle anterolateral thigh (ALT) free flap. The fibula free flap pedicle is anastomosed into side branches of the ALT free flap pedicle (pedicle-to-pedicle anastomosis), which is connected via an interposition vein grafts to the internal mammary artery and external jugular vein.

that clasps to the remaining teeth can be used to replace missing dentition in patients that have undergone mandibulectomy or maxillectomy. When a sizable segment of the tooth-bearing mandible or maxilla is excised, as well as in the edentulous patient, osseointegrated implants may be necessary to retain a dental prosthesis (► Fig. 1.12). Such implants may be placed at the time of osteocutaneous free flap reconstruction or, more commonly, secondarily. In general, when designing a mandibular or maxillary flap reconstruction, thought should go into creating a flat, firm, stable surface against which a dental prosthesis may rest. Flap skin paddle thinning or removal as well as hardware removal may be necessary to place implants and fixate a dental prosthesis via abutments that attach to the implants.

A subject of controversy is placement of implants in patients that receive postoperative radiation.¹² In many centers, osseointegrated implants are not offered to patients receiving

postoperative radiation due to concerns for complications such as failure to integrate, pathologic fracture, or development of osteoradionecrosis of the bone and surrounding soft tissues. In other centers, implants are placed early, either at the time of bony flap surgery or shortly thereafter, prior to beginning radiation. Occasionally, delayed bony reconstruction is performed if dental restoration with an implant-borne prosthesis is considered critical. However, secondary bony free flap reconstruction in an irradiated bed poses considerable challenges. Some centers will place osseointegrated implants into irradiated bone following a course of hyperbaric oxygen therapy, which is thought to reverse some of the unfavorable effects of radiation. In any case, early involvement of an experienced prosthodontist, preferably prior to the initial flap reconstruction, is important for surgical planning and ideal outcomes.

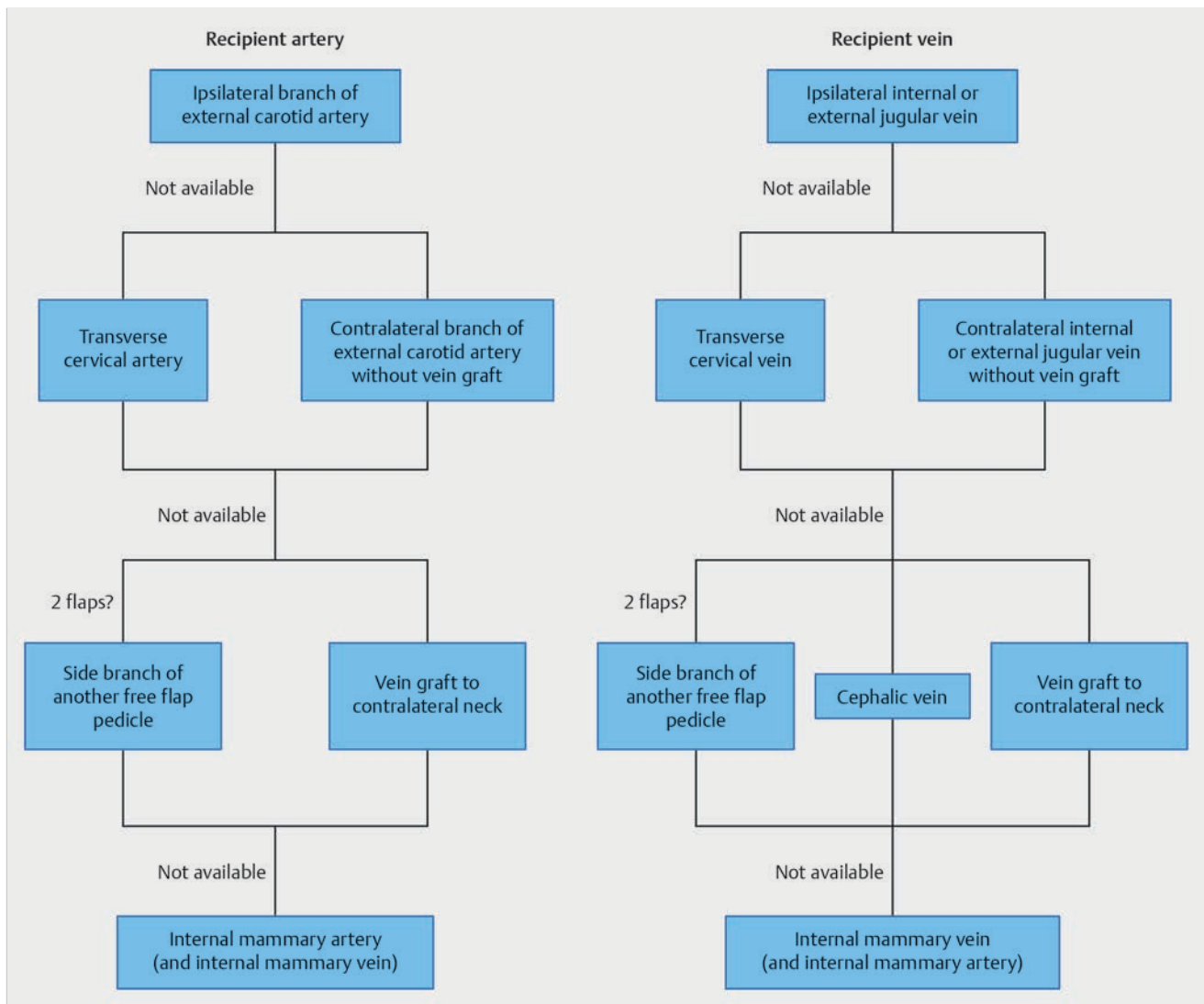


Fig. 1.11 Recipient blood vessel selection algorithm. Note that the difference between recipient artery selection and recipient vein selection is the inclusion of the cephalic vein as possible recipient vein.

1.7 Pearls and Pitfalls

- A thorough evaluation of the surgical candidate is critical for achieving success in microvascular surgery.
- Preoperative function should be ascertained, not only to determine what interventions are indicated, but also to convey a realistic functional and aesthetic prognosis to the patient.
- The possibility of needing multiple tissue components or even more than one flap should be considered during surgical planning, especially in previously irradiated patients in whom the external skin may need to be replaced to achieve stable neck wound closure.
- Locating satisfactory recipient blood vessels can be challenging, particularly in the previously operated or irradiated neck, in some cases requiring use of vein grafts as well as dissecting blood vessels outside of the head and neck area.
- Reconstruction is often a multistaged process, particularly for restoration of dentition, and patients should be counseled regarding the need for more than one surgery at the time of the initial consultation.

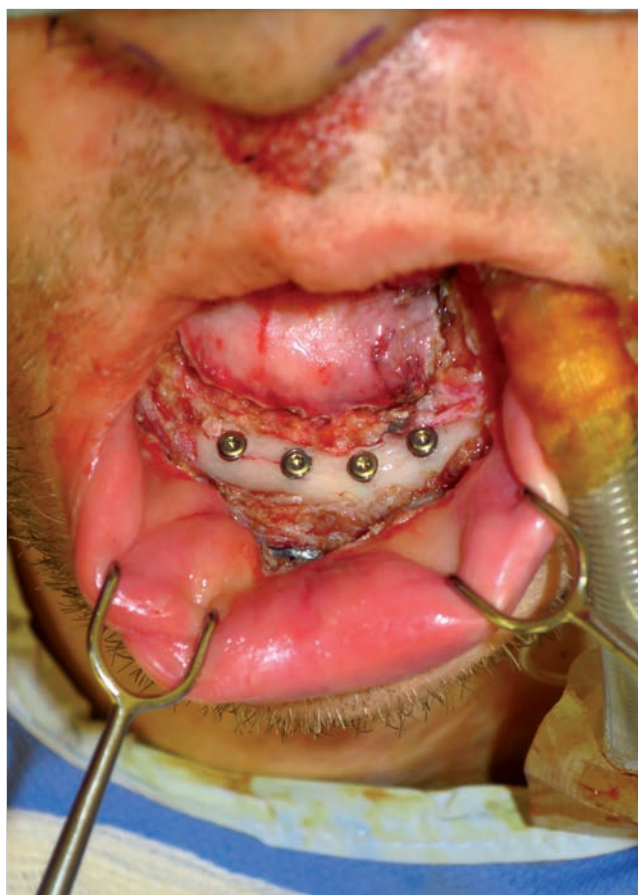


Fig. 1.12 Secondary placement of osseointegrated implants into a fibula free flap. Skin paddle thinning and hardware removal is often needed along with or prior to implant placement. The wound is then closed over the implants. The implants are uncovered about 3 to 4 months later and abutments that will be used to secure a dental prosthesis are attached.

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