Chapter 10: Head and Neck Reconstruction by Free Tissue Transfer

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The availability of revascularized free flap circumvents many limitations experienced with the use of local and regional flaps. The large number of free flap donor sites has greatly expanded the reconstructive possibilities for large skin, soft tissue, and composite defects of the head and neck. Each site has distinct advantages and disadvantages that must be addressed before the reconstruction.

Box 1. Advantages and disadvantages of revascularized tissue transfer in head and neck reconstruction

Advantages

Single-stage reconstruction
Simultaneous two-team approach
Improved vascularity
Unrestricted flap positioning
Large amounts of composite tension
Possibility for functional reconstruction (sensorimotor)

Disadvantages

Microsurgical technique
Long procedures
Labor-intensive procedures
Flap bulkiness
Functional disability
Possible color and texture mismatch with head and neck.

Although the ideal free flap has yet to be described, the variety of available flaps (both sensory and motor) and the almost unlimited design possibilities allow the reconstructive surgeon to customize the reconstruction to the defect site. Free tissue transfer is most commonly used in oromandibular reconstruction and the reconstruction of massive calvarial and cranial base defects; other indications include hypopharyngeal and cervical esophageal reconstruction, soft tissue augmentation of the face, and facial reanimation.

The reconstructive flap of choice should be easily dissected and have a long vascular pedicle consisting of an artery and vein with large luminal diameters. The flap should have color, size, and consistency characteristics similar to the native tissue. Finally, harvesting the flap should produce minimal donor site morbidity. This chapter will present the more commonly used donor free flaps for head and neck reconstruction.

Patient Selection

Patient selection is very important to the success of free tissue transfer surgery. The head and neck region has unique features that make it a particularly challenging site to the reconstructive microsurgeon. Because free flap reconstruction is most often used in the head and neck following cancer ablative surgery, the stage of disease and prognosis must first be carefully considered before committing the patient to a lengthy labor- and resource-intensive reconstructive endeavor.

Box 2. Ideal free flap donor site

Large amount of skin and soft tissue
Possibility for bone transfer
Muscle flap - possibility for motor innervation
Cutaneous flap - possibility for sensory reinnervation
Easy to harvest
Long vascular pedicle
Large-caliber vessel diameter
Minimal donor site morbidity.

Microvascular tissue transfer has been successfully performed in patients ranging in age from 18 months to over 70 years. Free tissue transfer in the pediatric age group may be more technically difficult to perform because of the smaller donor and recipient vessels, but, with careful preoperative planning and technique, complications should be no greater than in the adult population. Also, advanced age alone should not be a deterrent to microvascular surgery. Aging, however, is often associated with diabetes mellitus, hypercholesterolemia, and arteriosclerosis, which may result in thickening of the walls of small arteries and overall increased vessel fragility.

Arteriosclerotic plaque deposition is common in the branches of the external carotid system. These depositions may complicate the microsurgical technique by reducing blood flow or acting as a nidus for thrombus formation. The geometry of the anastomosis is very important in patients with atherosclerosis. Minor twisting or kinking of atherosclerotic vessels can further compromise blood flow and result in thrombosis. With meticulous microvascular technique and sound clinical judgment, free tissue transfer can be success fully accomplished in these patients. On the other hand, patients with blood coagulopathies, collagen vascular diseases, sickle cell disease, and polycythemia are not generally considered candidates for microvascular surgery.

Malnutrition is not a contraindication to free flap surgery, but malnourished patients are at risk for wound-healing problems and other postoperative complications, including free flap failure. Obesity also may influence the surgical result, particularly when direct cutaneous flaps are transferred from the groin or chest area. The increased adipose tissue may pose difficulties with dissecting of the vascular pedicle and in tailoring of the flap to the specific defect. This is particularly true when the oral cavity is the recipient site for the flap. Excessive soft tissue in the oral cavity may compromise blood flow to the flap. Although some soft tissue may be defatted at he time of transfer, excessive defatting may compromise the vascular pedicle.

Finding adequate recipient vessels for the anastomosis can be difficult. Radiation can cause injurious effects on small vessels that can lead to decreased patency and poor tissue survival rates. Irradiated human blood vessels manifest decreased smooth muscle density, endothelial cell dehiscence, and vessel wall fibrosis. Intramural wall dissection is more frequent. Often there is deposition of red and white microthrombi even after only a brief period of blood stagnation, and the intima is extremely fragile.

Finally, recipient vessel preference depends first on availability. The ideal situation allows for an end-to-end anastomosis of similar size-matched vessels. Unfortunately, head and neck cancer patients have often had prior neck procedures (that is, radical neck dissection, external carotid artery ligation) in which case potential recipient vessels are much less reliable. In cases where recipient vessels are limited, the entire external carotid system can be ligated and swung down into the neck for anastomosis, or vein grafts may be used to hook up with vessels in the opposite side of the neck.

Box 3. Uses for free tissue transfer in head and neck reconstruction

Mandible and maxilla reconstruction
Pharyngoesophageal / oral cavity / oropharynx reconstruction
Soft tissue augmentation
Skull base surgery
Facial palsy rehabilitation.

Cases in which patients have previously undergone bilateral radical neck dissections are extremely challenging, and free tissue transfer may be contraindicated under these circumstances. Preoperative arteriography may be helpful to identify adequate recipient vessels. In the absence of a suitable neck vein, the cephalic vein may be dissected freely in the arm and swung up over the clavicle to provide venous outflow.

Specific Donor Sites

Cutaneous flaps

Radial forearm flap

The radial forearm flap is a fasciocutaneous flap based on the radial artery and its venae commitantes or a superficial forearm vein. It has proven to be a reliable flap providing supple thin skin with a potential for sensory reinnervation. An extension of this flap to include a segment of the underlying radius has proved useful in reconstructing the facial bones, particularly the mandible.

Flap dissection that can be performed simultaneously with preparation of the recipient site is made easier by the long vascular pedicle and large-caliber vessels. It is ideally suited for reconstructing moderately large defects of the face, scalp, and oral cavity where a thin flap is desirable. The radial artery runs in the lateral intermuscular septum, which separates the flexor and extensor compartments of the forearm. It supplies the skin over the volar aspect of the forearm from elbow to wrist as well as a portion of the radius. Almost any portion of the forearm skin can be raised as a fasciocutaneous flap based on this artery providing direct fasciocutaneous vessels enter the fascia plexus.

The flap is drained by two systems of veins, the superficial and deep systems, which have frequent communications. Only one venous system must be preserved with the flap to ensure flap survival. Most commonly it is the venae commitantes that accompany the radial artery that are preserved.

The radial forearm skin is thin and pliable. The distal volar forearm skin is often hairless. The vascular pedicle cane be easily identified and marked before flap elevation because of its subcutaneous location. The pedicle is commonly 10 to 18 cm in length, and the arterial diameter is usually between 2 and 4 mm.

Box 4. Commonly utilized donor flaps and grafts

Cutaneous and fasciocutaneous

Radial forearm
Lateral arm
Lateral thigh
Superficial groin

Muscle and musculocutaneous

Serratus anterior
Rectus abdominis
Gracilis

Osteocutaneous

Scapula
Radial forearm
Dorsalis pedis
Fibula

Osteomusculocutaneous

Deep circumflex iliac crest
Internal oblique iliac crest

Grafts

Gastroomental
Omentum
Jejunum
Nerve.

Flap elevation. Flap elevation is facilitated with the arm under tourniquet control following elevation exsanguination. The margins of the flap are incised to the level of the subcutaneous fat. Only in very large flaps is any attempt made to preserve the subcutaneous veins. Smaller flaps and composite flaps that include a segment of the radius are designed to drain on the venae commitantes only.

The flap is initially raised at the ulnar border by incising through the skin, subcutaneous fat, and deep fascia. Dissection proceeds in the subfascial plane. The peritenons covering the flexor tendons are preserved, particularly when a skin graft will be required to close the donor defect.

Distally, the radial artery and venae commitantes are identified and ligated. Care is taken to identify and preserve the cutaneous sensory branch of the radial nerve, which provides sensation to the anatomic snuffbox region.

The skin flap elevation proceeds toward the radial border of the forearm. The subfascial plane of dissection ensures that the radial artery lying in the lateral intramuscular septum is elevated with the flap. Proximally, the radial artery dives deeply between the flexor carpi radialis and brachioradialis. The bellies of these two muscles are retracted with more proximal dissection. An extension of the skin incision superiorly facilitates dissection for a longer pedicle. The medial and lateral antebrachial nerves of the forearm are identified at the superior aspect of the skin flap and preserved in situations where a sensate flap is desired.

Once the flap has been elevated, the tourniquet is released and hemostasis is obtained. The viability of the flap is assured, and the flap is usually perfused for 15 to 30 minutes before dividing the vascular pedicle.

The donor defect is usually skin grafted. The forearm is splinted and immobilized in a functional position for 5 to 7 days. Occasionally when a small flap is used, an ulnar transposition flap may be used to close the donor defect.

Advantages. The radial forearm cutaneous flap is extremely reliable and provides a large amount of very thin skin. This skin, which is often hairless, is easily tubed for pharyngoesophageal reconstruction. The medial and lateral antebrachial nerves of the forearm provide the advantage for sensory reinnervation. The donor site is far enough from the head and neck region to allow a synchronous two-team approach.

Disadvantages. To prevent inadvertent vascular compromise of the hand, a preoperative Allen test is mandatory. If this test demonstrates a dominant radial artery, the flap may still be used provided the radial artery is reconstituted with a vein graft. The unsightly skin graft on the volar aspect of the forearm is another disadvantage with the use of this flap. Poor healing of skin graft may result in a functional limitation of the hand and fingers.

Lateral arm flap

The lateral arm fasciocutaneous flap is a versatile donor site of sensate soft tissue for reconstruction and augmentation of the head and neck. This flap receives its blood supply from the profunda brachii artery, in particular the posterior branch, the posterior radial collateral artery that courses through the lateral intermuscular septum of the arm. The lateral antebrachial cutaneous nerve of the arm, a branch of the radial nerve, provides the flap with a potential for sensory reinnervation.

The tissue of the lateral arm, depending on the habitus of the patient, is usually thin, hairless, and supple. The vascular pedicle is commonly 8 to 10 cm in length with luminal diameters measuring 1 to 2 mm.

The lateral arm flap can be easily harvested with the patient in the supine position. The central axis of the flap corresponds to a line drawn from the deltoid insertion near the midbody of the humerus to the lateral humeral epicondyle. The lateral intermuscular septum containing the neurovascular pedicle lies 1 cm posterior to this line.

The cutaneous territory supplied by the posterior radial collateral artery varies from 8 x 10 cm to 14 x 15 cm. However, the flap is usually limited to 6 cm to allow primary closure.

Flap elevation. Dissection of the skin paddle begins either anterior or posterior to the flap axis. Skin, subcutaneous tissue, and the deep investing fascia are incised and elevated. The intermuscular septum is carefully approached from each side and followed down to its insertion into the humerus. Brachioradialis muscle fibers insert directly into the intermuscular septum on its anterior surface and require careful sharp dissection. Posteriorly there is an identifiable plane between the triceps muscle fibers and the intermuscular septum, allowing for an easier initial approach. The posterior radial collateral vessels are visible in the intermuscular septum. The septum may then be divided distally with ligation of the distal extension of the posterior radial collateral vessels.

The radial nerve follows the intermuscular septum from the deltoid insertion to the superior border of the brachioradialis muscle, where it turns anteromedially away from the septum to continue between the brachialis and brachioradialis muscles. The neurovascular pedicle is easily dissected off the radial nerve.

A superior extension of the skin incision following the posterior border of the deltoid muscle will allow dissection of the pedicle high into the spiral groove of the humerus. This adds an additional 2 to 3 cm to the pedicle length. The donor site is usually closed primarily, and a light pressure is applied.

Advantages. The lateral arm fasciocutaneous flap is a versatile flap that is thin and supple with a thickness somewhere between that of the radial forearm free flap and the cutaneous scapular free flap. In a situation where the lateral arm flap provides more bulk than is desired, its cutaneous portion may be discarded and the flap transferred as fascia only or the subcutaneous fat may be covered with a split-thickness skin graft.

The lateral arm flap can be harvested quickly with the patient in the supine position without interference to the head and neck team. The posterior radial collateral artery is a nonessential vessel and consequently does not need to be reconstituted. The inferior antebrachial cutaneous nerve of the arm that runs with the vascular pedicle can be used to restore cutaneous sensation.

Disadvantages. Primary closure of the donor site is difficult with flaps larger than 6 cm in width. The two major sequelae at the donor site are the sensory deficit along the distribution of the posterior antebrachial cutaneous nerve and a noticeable linear scar along the upper arm.

Lateral thigh flap

The skin of the lateral thigh is usually thin and pliable except in obese patients who often have thick subcutaneous fat in the more proximal aspects of the lateral thigh. The vascular supply to the skin is through subcutaneous branches from the third perforator of the profunda femoris system. There also may be a contribution from the fourth perforator or terminal branch of the profunda femoris. In 15% of cases a direct cutaneous branch of the second perforator supplies the skin more proximal to the midthigh.

Even in male patients the lateral thigh skin is often hairless. The lateral thigh offers the greatest amount of expendable skin for free tissue transfer. The skin paddle may be as large as 25 x 14 cm and still allow primary closure of the donor site. The vascular pedicle is usually 6 to 12 cm in length with a luminal diameter measuring 2 to 4 mm. Another advantage to this flap is the potential for sensory reinnervation by the inclusion of a lateral femoral cutaneous nerve of the thigh.

Flap elevation. With the patient in the supine position, the leg is flexed at the hip and the knee, with the knee inwardly rotated. A line is drawn between the dorsal aspect of the greater trochanter to the dorsal aspect of the lateral condyle of the femur to delineate the intermuscular septum. The third perforator of the profunda femoris artery is usually located at the midpoint of this line. The flap is then designed along the intermuscular septum to include this perforator.

The initial skin incision begins anteriorly and is carried down through the skin and subcutaneous tissue. The lateral femoral cutaneous nerves are identified in the subcutaneous tissue at the superior aspect of the incision. Once these nerves have been identified, the incision is completed to the fascia of the iliotibial tract. The flap is raised in a plane superficial to the fascia lata.

On approaching the intermuscular septum, the physician should identify the third perforating branch and follow it as it courses through the filmy short head of the biceps femoris. The fourth perforating branch of the profunda femoris also may be identified in the distal aspect of the flap. This perforator on occasion will provide the major blood supply to the skin. With retraction of the vascular lateralis anteriorly, the vessels are followed to the linea aspera. At this point the vessels pierce this fascial barrier en route to the biceps. This fascial barrier must be incised to facilitate dissection of the vascular pedicle as far as the second perforated branch. The pedicle is divided at this point since the second perforator provides a significant supply to the major musculature of the leg. The donor site in almost every case can be closed primarily.

Advantages. The lateral thigh provides a fasciocutaneous flap that in most cases is thin, pliable, and hairless. There is essentially no donor site morbidity, and the flap's location distant from the head and neck allows for a synchronous two-team approach. Inclusion of the lateral femoral cutaneous nerve of the thigh with this flap provides for neurosensory capabilities.

Disadvantages. The occasionally variant vascular anatomy as well as the dissection of the pedicle in the region of the linea aspera makes the dissection of the lateral thigh flap more difficult than that of the other soft tissue flaps. The flap may be moderately thick but rarely exceeds 3 to 4 cm even in patients with generous subcutaneous tissue in the lateral thigh region.

Muscle flaps

Latissimus dorsi flap

The latissimus dorsi is a broad, flat muscle that occupies the region of the lateral back. In 1906 Tansini reported using a rotational latissimus dorsi flap in postmastectomy reconstruction. The use of the latissimus dorsi myocutaneous flap as a free microsurgical flap was not reported until 1978, at which time it was used for reconstruction of an extensive scalp defect. The role for this flap either as a pedicled flap or a free flap in head and neck reconstruction is still reserved for coverage of extensive defects.

The latissimus dorsi muscle occupies the region fro the scapular tip to the iliac crest and from the posterior midline to the posterior axillary fold. The muscle itself generally measures 25 x 35 cm, and the overlying cutaneous territory that is supplied by perforators from the muscle measures 30 x 40 cm. Any portion of the cutaneous territory overlying the muscle may be safely transferred with the flap, including a random cutaneous extension up to 5 cm beyond the lateral border of the muscle.

The muscle takes its origin from the iliac crest and external oblique fascia inferiorly across to the thoracolumbar fascia and lower six vertebrae posteriorly. The muscle fibers then course anteriorly below the scapular tip and form the visible landmarks of the posterior axillary fold. Finally the latissimus dorsi muscle traverses the axilla and inserts anteriorly into the intertubercular groove of the humerus.

The latissimus dorsi is an adductor and medial rotator of the arm. These functions are best demonstrated during the follow-through motions of swimmers or cross-country skiers. Except in patients who avidly pursue these activities, the functional loss of the latissimus dorsi can be accommodated by the remaining local musculature.

Flap elevation. The latissimus dorsi muscle receives its main blood supply from the thoracodorsal artery, a terminal branch of the subscapular artery. This vessel supplies the upper two thirds of the muscle, whereas the lower one third is supplied segmentally by the ninth to eleventh intercostal arteries. The neurovascular pedicle enters the undersurface of the muscle approximately 8 to 10 cm below the axillary vessels in a line that corresponds to the anterior edge of the muscle. The thoracodorsal artery usually splits into a horizontal branch and a vertical branch several centimeters from the hilum. The vertical branch parallels the muscle border 1 to 4 cm medial to the edge. The horizontal division parallels the upper muscle border 3.5 cm inferior to the edge. The motor nerve to this muscle - the thoracodorsal nerve - also divides several centimeters beyond the hilum. The nerve branches parallel the arterial branches. This consistent neurovascular anatomy reliably allows for the flap to be divided into two independent myocutaneous flaps, each with its own innervation and blood supply.

Advantages. The latissimus dorsi flap offers tremendous versatility for head and neck reconstruction. The neurovascular structures may be dissected proximally into the axilla to provide a pedicle length of 8 to 15 cm long, or the flap may be used as a free flap. The muscle itself may be used and skin grafted, or a myocutaneous flap can be harvested. Donor site defects up to 10 cm can usually be closed primarily.

The latissimus dorsi flap provides a large amount of well-vascularized tissue, which is ideally suited for massive defects of the face, scalp, skull base, and tongue. The bulkiness of this flap diminishes with muscle atrophy when the thoracodorsal nerve is sectioned during the harvest.

Disadvantages. There is essentially no donor site morbidity except in patients who might want to pursue swimming or cross-country skiing. The most common postoperative complications seen at the donor site are seroma and hematoma formation.

Rectus abdominis flap

The rectus abdominis muscular cutaneous free flap based on a deep inferior epigastric artery and vein is one of the most versatile flaps used in head and neck reconstruction. Like the latissimus dorsi flap, a large amount of skin can be harvested with the rectus muscle and still allow primary closure. The ability to design skin paddles with a vertical, oblique, or transverse orientation allows for reconstruction of complex three-dimensional defects. This donor site is at a distance from the head and neck so that a two-team approach can be comfortably used.

Although the rectus abdominis flap is commonly used as a myocutaneous flap for transferred skin, this flap can be harvested as a muscle flap or a myofascial flap.

Flap elevation. The primary consideration in designing a rectus abdominis flap is the size, shape, vascularity, and thickness of the tissue that is to be transferred. The skin flap design must incorporate the cutaneous perforating branches that are concentrated in the periumbilical region. The initial skin incision is carried down to the rectus fascia. The fascia is incised superiorly, following which the medial and lateral limits of the muscle are identified. The skin incision is extended to the pubis, and the anterior rectus fascia is exposed. The anterior rectus fascia should be preserved below the arcuate line. Below this line the absence of the posterior rectus fascia mandates that additional measures be taken to strengthen the abdominal wall following flap harvest.

The rectus muscle is easily separated from the posterior sheath superiorly. On the undersurface of the muscle, the deep inferior epigastric vessels can be easily identified. These vessels are followed to the parent external iliac vessels. The muscle is then divided inferior to where they begin to arborize in the muscle.

Advantages. The rectus abdominis muscle flap and myocutaneous flap are versatile flaps for head and neck reconstruction. The rectus abdominis flap can be harvested with the patient in the supine position. The vascular pedicle usually measures 15 cm in length with large-diameter vessels. The myriad number of different skin paddle orientations that can be designed only adds to the versatility of this flap.

Disadvantages. The rectus abdominis muscle is a major component for support of the anterior abdominal wall. Removal of this support and in particular removal of the anterior rectus fascia below the arcuate line may lead to ventral hernia formation. In some individuals the skin component of this flap may be too bulky. In these individuals the skin may be taken off in a subcutaneous plane and the flap skin grafted or the muscle alone may be transferred. The color match of the abdominal skin for the face is also not ideal.

Bone flaps

Internal oblique iliac crest osseomyocutaneous flap

The iliac crest is recognized as an excellent donor site for nonvascularized corticocancellous bone. Its thickness and natural shape relative to other bone graft sources make it an ideal replacement for the mandible. The iliac crest can also be transferred as an osseomyocutaneous free flap supplied by the deep circumflex artery and vein. Modifications that incorporate the internal oblique muscle flap with the iliac crest bone and skin have greatly expanded the utility of this flap. This muscle, based on the ascending branch of the deep circumflex iliac artery and vein, is large, thin, and pliable and can be manipulated in three dimensions relative to the bone. The creation of buccal and lingual sulci for oral rehabilitation is facilitated by wrapping the thin internal oblique muscle over the iliac crest bone and applying a split-thickness skin graft. The internal oblique muscle also contours well to intraoral or pharyngeal wall mucosal defects. The skin paddle of the flap may then be dedicated to reconstructing external cutaneous defects.

The iliac crest provides a stock of bone that is ample for dental rehabilitation implants. With strategically placed ostectomies, this bone contours well to defects of the mandible and in particular the anterior symphyseal region. Up to 18 cm of bone in length can usually be transferred with this flap.

The deep circumflex iliac artery provides excellent vascularity to the iliac crest through both endosteal and periosteal branches. The vascular anatomy is usually consistent. The vascular pedicle may be 6 to 8 cm in length with luminal diameters of 1 to 2 mm. These somewhat smaller vessels may make flap dissection slightly more tedious.

Flap elevation. Because of its distant location, the iliac crest can be harvested simultaneously with activity at the head and neck site. The flap is harvested with the patient in the supine position and the ipsilateral hip slightly elevated. An elliptic skin flap is designed over the iliac crest with its main axis along a line extending from the anterior superior iliac spine to the inferior border of the scapula. The skin incision is extended medially parallel to the inguinal ligament to the femoral vessels.

With the superior skin incision the external oblique muscle is divided at least 3 cm superior to the iliac crest. The internal oblique muscle is exposed and elevated along its borders. The plane between the internal oblique and the transverse abdominis is identified and meticulously dissected until the ascending vascular pedicle is identified on its undersurface. This broad sheet of muscle is elevated to within 3 cm of the iliac crest, and the ascending branch is then traced medially through the transverse abdominis to its junction with the deep circumflex iliac artery and vein. Further dissection exposes the external iliac vessel. The transversus abdominis muscle and the transversalis fascia are then incised. The preperitoneal fat is retracted medially to expose the iliacus muscle, which is incised down to the level of the inner periosteum leaving a 2 cm cuff of muscle to protect the deep circumflex vessels.

The inferior skin paddle insertion is incised down to the level of the tensor fascia lata and the fascia overlying the gluteus medius. The tensor and gluteus medius are stripped from the bone, and a template of the resected mandible segment is used to outline the bone cuts.

Donor site closure is performed by approximating the transversalis fascia and transversus abdominis muscle to the iliacus muscle. In addition, drill holes are made in the iliac bone, allowing for direct approximation of the transversalis fascia and muscle to the bone. Occasionally Marlex mesh may be needed to bolster the inner layer of closure when the transversus abdominis is inadequate. The external oblique muscle and fascia are closed to the tensor fascia lata and gluteus medius.

Advantages. The iliac crest provides a substantial stock of corticocancellous bone that stimulates the length, width, and natural contour of the native mandible. The available bone length is ample to reconstruct mandibular defects from angle to angle.

The addition of the internal oblique muscle with the flap greatly expands its utility. This thin, pliable muscle provides better contour for more difficult three-dimensional defects of the oral cavity and pharynx. Within several months following surgery, and denervated internal oblique muscle atrophies with a resultant thin layer adherent to the underlying bone segment.

Disadvantages. Perhaps the greatest disadvantage of this flap concerns the bulky nature of its soft tissue and skin. Correct utilization of the internal oblique muscle may lessen this concern. The skin paddle must maintain a broad attachment to the iliac crest bone. This essentially limits the amount of rotation of the skin paddle relative to the bone, making the skin paddle less suitable for external cheek reconstruction.

Harvesting of this flap involves division of many lower abdominal muscles as well as division of the lingual ligaments. These patients are at risk for groin hernia formation. Hypesthesia of the lateral thigh is occasionally encountered because of injury or sacrifice of the lateral cutaneous nerve of the thigh, which courses through the area of dissection. Hip weakness and pain causing a slight limp generally subside after several weeks.

Scapular flap

The lateral back region is a virtual "gold mine" to the reconstructive surgeon. The axillary artery has several branches that can support a number of donor free flaps. One branch in particular, the circumflex scapular artery, which originates from the third portion of the axillary artery, supports the scapular flap. The scapular flap can be harvested as a fasciocutaneous or an osseocutaneous flap to reconstruct a variety of defects about the head and neck.

A large amount of hairless skin can be harvested with this flap. It has a rich subcutaneous vascular network so that it may be deepithelialized and folded on itself for reconstructing combined defects of the oral cavity and facial skin. The skin of the scapular flap is pliable, and its texture is similar to that of the face. The scapular skin color probably approaches that of the facial skin more than any other free flap donor site.

The vascular pedicle, which is commonly 6 to 8 cm in length, gives off several small branches that support the periosteum of the lateral border of the scapula. Beyond this point the terminal branches support the skin paddle, which can be manipulated independent of the bone flap. Large skin flaps can be harvested. Flaps as large as 14 x 21 cm can be successfully transferred. The skin flap can be based on the horizontal (scapular) or descending (parascapular) cutaneous branch of the circumflex scapular artery or both if a large paddle is required.

The lateral border of the scapula is an excellent source of highly vascularized corticocancellous bone 1.5 x 3 cm thick and 10 cm long in petite women and 14 cm long in larger men.

Flap elevation. Flap elevation is ideal if the patient is placed in the lateral decubitus position. In most circumstances this position allows for adequate exposure of the head and neck for the resection and synchronous surgery by the resection team and flap-harvesting team.

The triangular space can be easily palpated in most patients. Whether a scapular flap, a parascapular flap, or a combination of these two flaps is chosen, they are outlined in an elliptic fashion over the appropriate cutaneous vessels. Although it is not necessary to do so, the cutaneous vessels can be identified with a hand-held Doppler probe and outlined before flap elevation. The flap skin is elevated in a plane that preserves the fascia over the underlying muscle. Pedicled vessels can be found on the undersurface of the flap during elevation. Dissection proceeds to the superior border of the teres major muscle, where the cutaneous vessel can be identified in the fat of the triangular space. Once the pedicle vessels have been found diving through the triangular space, careful dissection is required along with retraction of the teres muscles to open the axilla.

The branches of the circumflex scapular vessel that enter the lateral border of the scapula must be carefully sectioned when a skin-only flap is being harvested. These branches are preserved with the osseocutaneous flap. The teres major and minor muscles are also dissected free fro the lateral border of the scapula when the osseocutaneous flap is harvested. Proximal dissection required identification and appropriate ligation of the thoracodorsal vessels and the branches of the circumflex scapula arteries supplying the teres major and subscapularis muscles. The pedicle is carefully dissected proximally to the subscapular vessels, at which point the venae commitantes usually join to form a single vein.

The length of the vascular pedicle, with this proximal dissection, ranges from 8 to 12 cm. The luminal diameter of the subscapular vessels range from 3 to 4 mm. Further dissection of an osseocutaneous flap may require detaching a small portion of the long hand of the triceps muscle. The infraspinatus muscle overlying the bone flap is divided, and with an oscillating saw the lateral quarter of the scapular muscle can be included with the flap. The final dissection involves freeing the bone from the attached subscapular muscle.

The teres muscles and long head of the triceps are reattached to the lateral border of the scapula with a permanent suture. The donor skin defect is closed primarily.

Advantages. The scapular cutaneous skin flap and osseocutaneous flap are extremely reliable and provide a large amount of skin in either one of two paddles. The length of the vascular pedicle is advantageous for defects of the lateral temporal bone and scalp.

The lateral scapular bone is usually of sufficient width and length to accommodate most hemimandibular defects. Future implantation of the bone for purposes of dental rehabilitation will probably require smaller implants that may not anchor as securely.

Disadvantages. The skin on the scapular region can be quite thick, particularly in obese patients. Although there is essentially no morbidity associated with harvesting the scapular cutaneous flap, there may be considerable disability to shoulder range of motion and arm strength with harvesting the osseocutaneous flap. These patients may experience limitations in abduction, flexing, and external rotation. It is highly recommended that these patients be treated by a physical therapist. There is no provision for innervation of these flaps.

Fibular flap

Recently reconstructive surgeons have expressed enthusiasm for the fibula as a potential donor site for revascularized bone. The fibula has had wide application as a source for long bone replacement in extremity trauma and cancer. Many features make it appealing as a donor site for reconstruction of bony defects of the head and neck. The fibula, which is 25 cm in length, is ample to reconstruct any length mandibular defect. Although the volume of this bone may not be as great as the iliac crest or scapula, implants can be secured by its thick cortex.

The fibula flap can be conveniently dissected with the patient in the supine position. Its distant location to the head and neck accommodates a two-team approach.

The skin and soft tissue overlying the fibula may be harvested with the bone flap although its reliability may occasionally be suspect. The vascularity to the skin depends on septocutaneous vessels running in the intermuscular septum or musculocutaneous perforators that traverse the soleus muscle. The skin paddle design must incorporate at least one of these vessels, which arise randomly along the intramuscular septum. The fibula is harvested through a lateral approach. The skin paddle is centered on a line between the head of the fibula and the lateral epicondyle, which delineates the intermuscular septum. Dissection is performed with a tourniquet inflated to 450 mm Hg.

The anterior skin flap is raised with the deep fascia from the lateral compartment musculature and remains attached to the bone only by the intermuscular septum. The posterior skin paddle is raised in a similar fashion fro the superficial posterior compartment musculature. Musculocutaneous perforating vessels passing through the soleus muscle are preserved. The lateral compartment muscles are freed from the fibula. The septum between the lateral and anterior compartments is then divided, and the anterior compartment muscles are also freed from the bone. On the undersurface of the interior compartment musculature lie the anterior tibial vessels and the deep peroneal nerve, which are preserved. The interosseous membrane is then divided.

In cutting the bone, 6 cm of fibula is preserved proximally and distally to ensure stability. With the bone segment retracted laterally, the tibialis posterior is divided and the vascular pedicle identified as it courses distally parallel to the bone. The peroneal vessels are ligated inferiorly. The flexor hallucis longus muscle is separated from the pedicle, and a cuff of soleus muscle is preserved with the flap to protect the musculocutaneous perforators. Donor site is usually closed primarily.

Advantages. The fibula is a non-weight-bearing bone in humans. Therefore sacrificing the fibula is of no functional consequence. There is ample bone length available to reconstruct the entire mandible. The periosteal blood supply is abundant and permits multiple osteotomies for contouring the graft to simulate the shape of the mandible. Although the volume of the fibula usually is less than the native mandible, the thickness of bony cortex will accommodate dental implants.

Donor site morbidity is negligible. Donor site wounds less than 6 cm in width are most often closed primarily. Wider skin flaps may require skin grafting the donor defect.

Disadvantages. The random location of the septocutaneous and musculocutaneous perforators along the lateral border of the fibula contributes to the unreliability of the skin island blood supply. Ultrasound Doppler assessment of these perforators preoperatively as well as incorporation of a cuff of soleus muscle with the bone flap undoubtedly improves the chances of skin island survival. The smaller skin island available with the fibula flap may also limit its utility for large composite defects of the head and neck.

Free jejunal autograft

The free jejunal autograft is an option in pharyngoesophageal reconstruction. The lumen of the jejunum is a good match with the cervical esophagus and maintains an ideal epithelial surface for food transit. The jejunum may be used as a free mucosal patch by splitting it along its antimesentery border for oropharyngeal reconstruction or as a complete interposition conduit based on the superior mesenteric vascular arcade. Despite the need for a laparotomy, the operation remains extrathoracic, thereby decreasing the potential morbidity and mortality.

Flap elevation. The jejunal graft is usually harvested by a general surgeon and can usually be performed simultaneously with the head and neck team. The direction of the peristalsis is marked by a suture placed at the proximal end of the graft to ensure an isoperistaltic bowel and anastomosis. Transilluminating the mesentery will facilitate selection of a bowel segment with sufficient arborization within the vascular arcade to supply the graft. Selection of the vascular pedicle within the mesentery is made easier while the vessels are under stretch. The jejunum is chilled to reduce its metabolic requirements before revascularization.

Advantages. The mucous membrane-lined jejunal conduit represents the most physiologic replacement for the pharyngoesophagus. It tolerates postoperative radiation therapy well and maintains adequate mucous production.

Disadvantages. Harvesting of this flap is associated with some very serious potential intraabdominal complications.

Postoperative ileus and problems related to the gastrostomy or jejunostomy tube may prolong the patient's hospitalization. Postoperative adhesions with subsequent bowel obstruction are a later risk, as with any laparotomy.

Stricture of the upper or lower pharyngoesophageal anastomosis occurs in roughly 10% of free jejunal transfers and usually responds to dilation. Transient postoperative hypersecretion and uncoordinated peristalsis may contribute to dysphagia and regurgitation. Successful vocal rehabilitation may also be hampered by the rugal folds of the jejunum.

Summary

Free tissue transfer has added an exciting new dimension to the otolaryngologist - head and neck surgeon's list of reconstructive options. The myriad of potential donor sites provides for a more customized reconstruction and, it is hoped, a more aesthetic as well as functional result. Which particular free flap is used depends on the demands of the defect in addition to the training and experience of the reconstructive team.

With free tissue transfer expected success rates of 90+%, the head and neck reconstructive surgeon's attention can now be directed at restoring function. Dental implants into revascularized bone, sensate flaps, and motor flap will highlight future investigations. However, more objective means of classifying and assessing the anatomic and functional deficit, with objective measures of postoperative cosmetic and functional outcome, must be established. Until this type of detailed analysis is performed, meaningful comparisons between different reconstruction methods will be difficult.