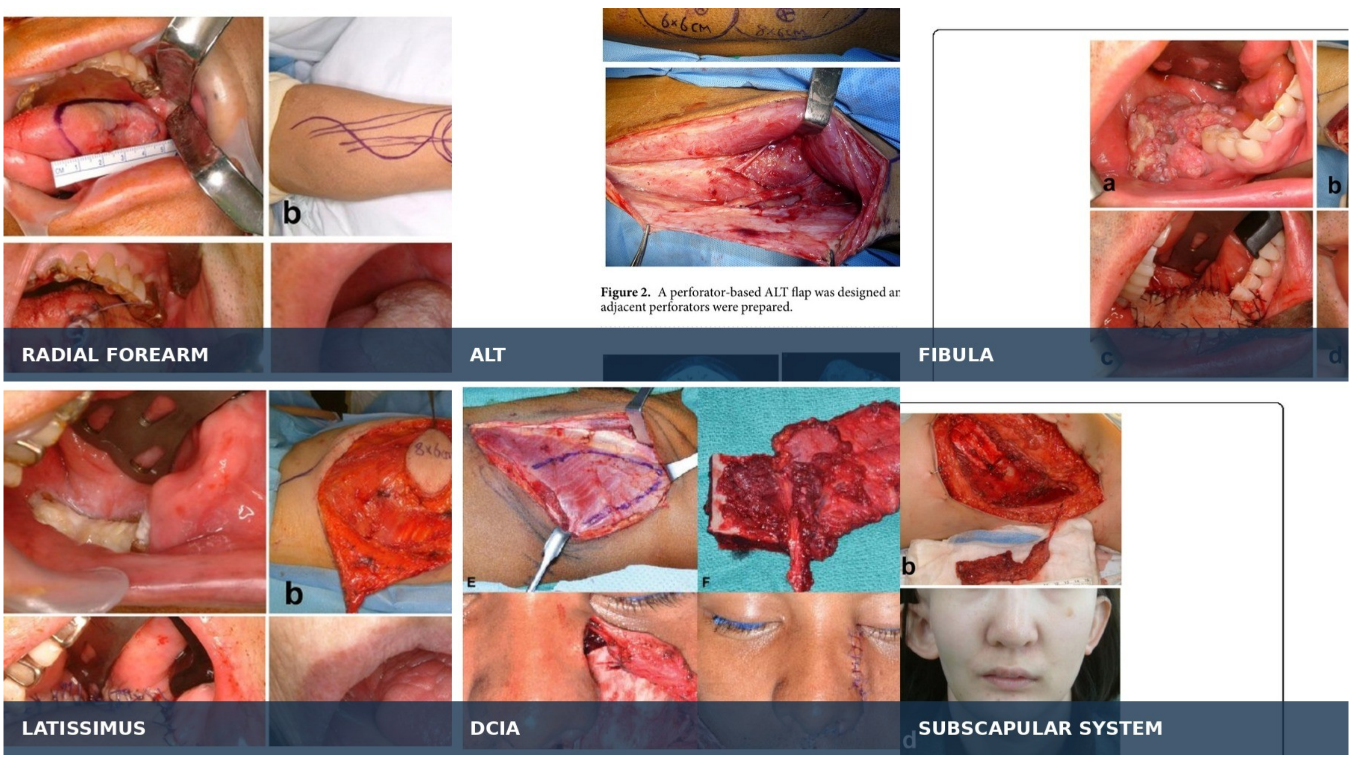
FREE-FLAP RECONSTRUCTION FOR HEAD AND NECK CANCER

VOLUME II

The Free-Flap Toolkit

Donor anatomy, harvest concepts, indications, limitations, and donor-site tradeoffs



Cover montage. *Representative radial forearm, anterolateral thigh, fibula, latissimus, DCIA, and subscapular-system reconstructions. Open-access web figures; full credits in Appendix D.*

A resident-level guide to the tissue-transfer armamentarium

Resident study guide • July 2026

CHAPTER 0

Orientation

How to learn donor sites without turning reconstruction into a memorization exercise

THE GOVERNING PRINCIPLE

A donor site is not a diagnosis-specific answer. It is a package of tissues, supplied by a pedicle, that carries a predictable set of geometric advantages and donor-site costs.

Volume I established a defect-first method: define what has been removed, identify the barrier, lining, cover, volume, structure, conduit, and dynamic requirements, and only then choose a construct. Volume II turns to the other half of that equation. It asks what each donor site can reliably supply, how that tissue is vascularized, how the components can be arranged, what must be assessed before harvest, and what functional price the patient pays at the donor site.

The goal is not to make the resident an independent microsurgeon from a written guide. The goal is to make the resident useful and safe in the operating room, able to anticipate the harvest, recognize the relevant anatomy, understand why the attending chooses one flap over another, and answer boards questions without reducing reconstruction to slogans. Harvest details vary among surgeons and institutions. The anatomy and the reasoning do not.

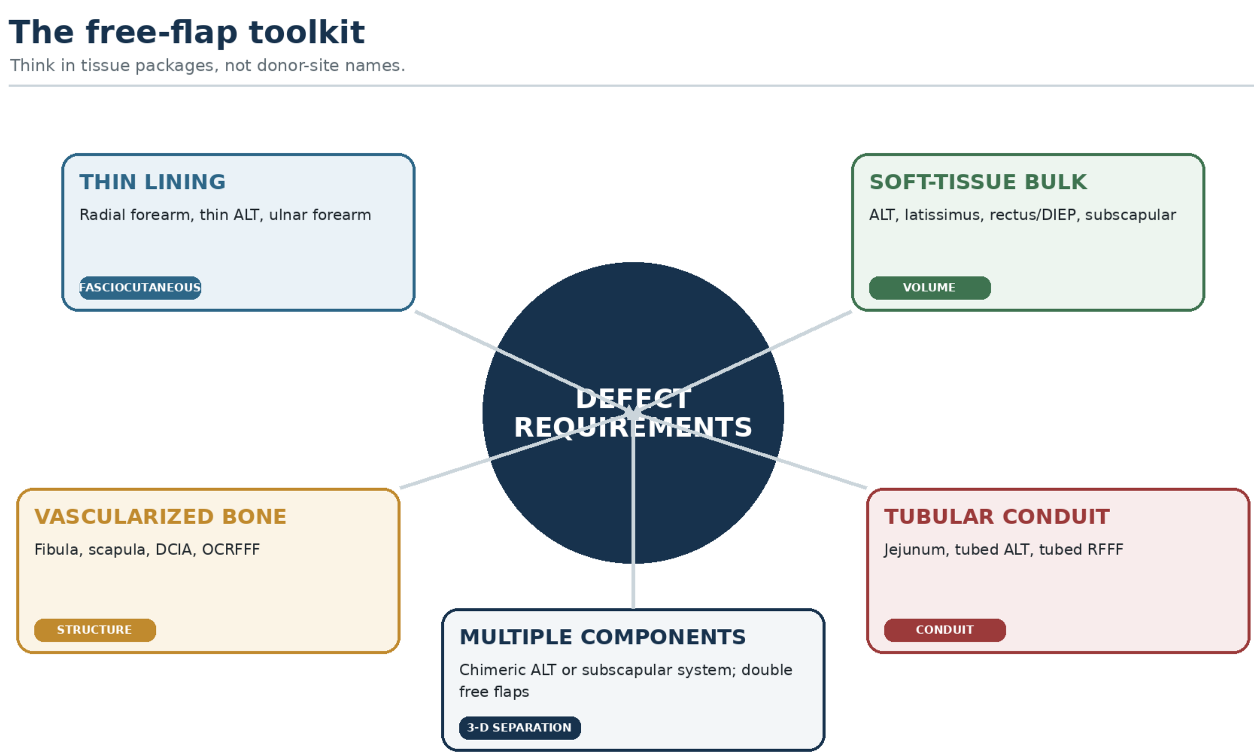


Figure 1. The free-flap toolkit organized by the tissue problem it solves. Several donor sites can occupy the same category; the choice depends on geometry, pedicle, patient factors, and donor-site cost. Original synthesis diagram created for this guide.

Learning objectives

After completing this volume, the resident should be able to:

1. Describe the source artery, venous drainage, dominant tissue branches, and clinically relevant nerves for the major head and neck free flaps.
2. Explain the difference between axial, perforator, musculocutaneous, septocutaneous, osteocutaneous, chimeric, and flow-through designs.
3. Perform a focused preoperative donor-site assessment for the forearm, thigh, leg, back, iliac crest, and abdomen.
4. Compare the radial forearm and anterolateral thigh flaps for thin lining and soft-tissue reconstruction.
5. Compare fibula, scapular-system, DCIA, and osteocutaneous radial forearm options for vascularized bone.
6. Identify the situations in which muscle, visceral tissue, or a less common rescue flap solves a problem that a standard fasciocutaneous flap does not.
7. Anticipate major donor-site complications and explain them in anatomically coherent terms.
8. Generate a primary and backup donor plan for common clinical scenarios and answer boards-style flap-selection questions.

How each flap chapter is structured

Table 1. *The recurring framework used for each donor site.*

Question	Why it matters
What does the flap provide?	Defines whether it supplies thin lining, volume, fascia, muscle, bone, a tube, or multiple independent components.
What is the vascular anatomy?	Determines pedicle length and caliber, skin-paddle reliability, osteotomy freedom, and the structures at risk during harvest.
How is the donor site evaluated?	Prevents catastrophic selection errors such as sacrificing a dominant artery or choosing a limb with poor healing potential.
What is the harvest concept?	Allows the resident to understand the sequence and anticipate retractors, tourniquet use, positioning, and pedicle division.
Where does it excel?	Connects tissue characteristics to common head and neck defects.
What are the tradeoffs?	Prevents “workhorse” from being mistaken for “best in every patient.”
What is boards-relevant?	Emphasizes classic anatomy, contraindications, and comparisons that are frequently tested.

CHAPTER 1

How to Read a Free Flap

Pedicle language, perforators, tissue components, and the preoperative donor-site audit

Every flap can be understood by tracing a simple chain: a source vessel gives rise to a harvestable pedicle; the pedicle gives off branches to skin, fascia, muscle, bone, or bowel; those branches determine which components can be transferred together and how independently they can move. Once that chain is clear, the operative anatomy becomes far less arbitrary.

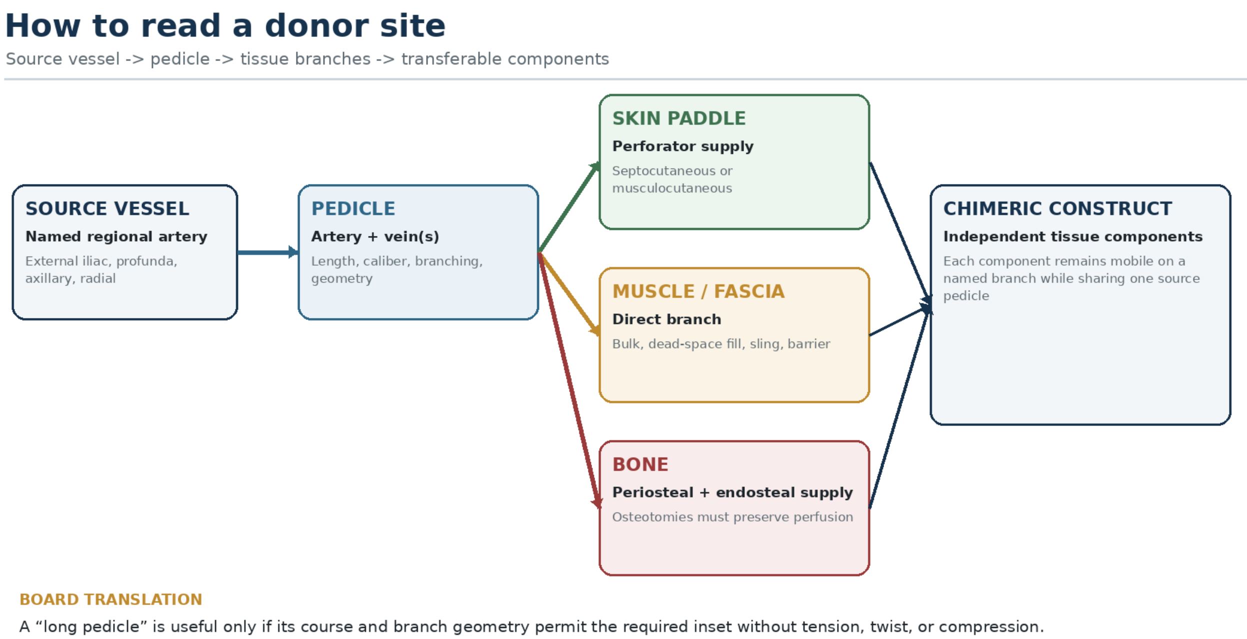


Figure 2. A practical vocabulary for reading donor anatomy. The important question is not only which artery supplies the flap, but how the tissue branches are arranged relative to one another. Original synthesis diagram created for this guide.

Axial flaps and perforator flaps

An axial fasciocutaneous flap contains a named vessel running along its long axis. The radial forearm flap is the prototypical example: the radial artery and venae comitantes travel beneath the deep fascia and give off numerous branches to the overlying skin. The skin paddle can therefore be designed over a broad, predictable territory, and the pedicle can be dissected proximally to obtain length.

A perforator flap is based on one or more vessels that leave a deeper source artery and pass through or between muscles to reach the skin. The anterolateral thigh flap is the classic head and neck example. The source system is reliable, but the individual perforator course is variable. The dissection may be straightforward when a septocutaneous perforator runs through an intermuscular septum or more tedious when a musculocutaneous perforator must be traced through vastus lateralis. This variability is not a minor anatomical curiosity; it affects harvest time, the amount of muscle sacrificed, the feasibility of thinning, and the ability to create multiple independent paddles.

Composite, osteocutaneous, and chimeric constructs

A composite flap transfers more than one tissue type. An osteocutaneous fibula flap, for example, carries vascularized bone and a skin paddle. The components remain linked by their shared vascular supply. A chimeric flap goes a step further: two or more tissue components are supplied by separate named branches that join a common source pedicle. Because each component can rotate or translate with relative independence, chimeric designs are particularly useful when the defect contains spatially separated requirements, such as intraoral lining, external skin, dead-space obliteration, and bone.

The subscapular system is the most expansive chimeric platform in routine head and neck reconstruction. The ALT can also be configured as a chimeric flap by including separate skin paddles, fascia lata, and a segment of vastus lateralis on distinct branches. The term should not be used simply because a flap contains two tissue types; the key concept is independent component mobility on separate branches of a common pedicle.

Pedicle length, caliber, and geometry

Pedicle length is often quoted as though it were an isolated quality. In practice, useful length depends on where the pedicle enters the flap, whether branches can be divided safely, the direction in which the tissue must be inset, and where the recipient vessels lie. A long pedicle can still be unusable if it exits on the wrong side of a bulky construct or must make an acute turn beneath a plate. Conversely, a shorter pedicle may be ideal when the flap geometry places it directly beside a favorable recipient artery and vein.

Caliber matters because extreme mismatch makes anastomosis more difficult, but caliber alone does not determine reliability. Vein quality, pedicle orientation, vessel wall condition, prior radiation, and the absence of compression or kinking often matter more than a millimeter of theoretical diameter. The resident should learn to ask where the pedicle will lie after the final inset, not merely how long it measures on the back table.

The donor-site audit

Donor-site selection is a second patient evaluation, not a clerical step after the reconstructive plan has been chosen. The exam should identify prior surgery or trauma, vascular disease, scars, neuropathy, edema, dominant-hand considerations, functional demands, and the patient's tolerance for an exposed or grafted donor site. Imaging is selective for some flaps and routine in many programs for others, particularly the fibula.

Table 2. *Focused donor-site assessment before free-flap harvest.*

Donor site	Focused examination	Common additional testing
Forearm	Pulses, hand perfusion, scars, IV/arterial-line history, sensory deficits, dominant hand, skin quality.	Allen or modified Allen testing; Doppler or pulse-ox/Barbeau assessment when used locally; vascular imaging if exam is abnormal or history is concerning.
Thigh	Scars, body habitus and thickness, prior femoral access, strength, gait, skin quality.	Handheld Doppler perforator mapping; CTA is selective rather than universal in many centers.

Donor site	Focused examination	Common additional testing
Fibula / lower leg	Dorsalis pedis and posterior tibial pulses, edema, scars, ankle stability, neuropathy, gait, venous disease.	CTA, MRA, or duplex according to institutional protocol; many centers routinely image to define three-vessel runoff and peroneal dominance.
Subscapular system	Shoulder motion, prior axillary surgery or radiation, back scars, body habitus.	Imaging is usually selective; CTA may help in complex or previously operated donors.
Iliac crest	Abdominal wall integrity, prior pelvic or inguinal surgery, hernia, gait and hip symptoms, skin-fold anatomy.	CTA may be used for planning; review prior abdominal or pelvic imaging when available.
Jejunum / abdomen	Prior laparotomy, bowel disease, obstruction history, nutritional status, hernia.	Cross-sectional imaging and general-surgery input as indicated; no routine “flap mapping” equivalent.

RESIDENT HABIT

Before the case, know the primary donor, the backup donor, which side is planned, whether vascular imaging has been reviewed, and what finding would make the team abandon that donor.

The “dominant vessel” problem

Most free-flap harvests sacrifice a named artery without causing ischemia because parallel circulation remains intact. The danger is anatomical variation or acquired disease that makes the proposed donor artery essential to the distal limb. The classic examples are an incomplete palmar arch before radial artery harvest and a peronea arteria magna or otherwise peroneal-dominant leg before fibula harvest. A reassuring skin color after temporary compression is not a substitute for a coherent vascular assessment when the history or exam is abnormal.

BOARDS PEARL

Radial forearm harvest depends on adequate ulnar-dominant hand perfusion. Fibula harvest depends on adequate anterior and posterior tibial circulation with no dominant peroneal artery supplying the foot.

CHAPTER 2

Radial Forearm Free Flap

The benchmark for thin, pliable, reliable lining

ONE-SENTENCE IDENTITY

The radial forearm free flap provides a thin, supple skin paddle with a long, dependable pedicle and excellent inset freedom, at the cost of a conspicuous, commonly skin-grafted donor site and sacrifice of a major forearm artery.

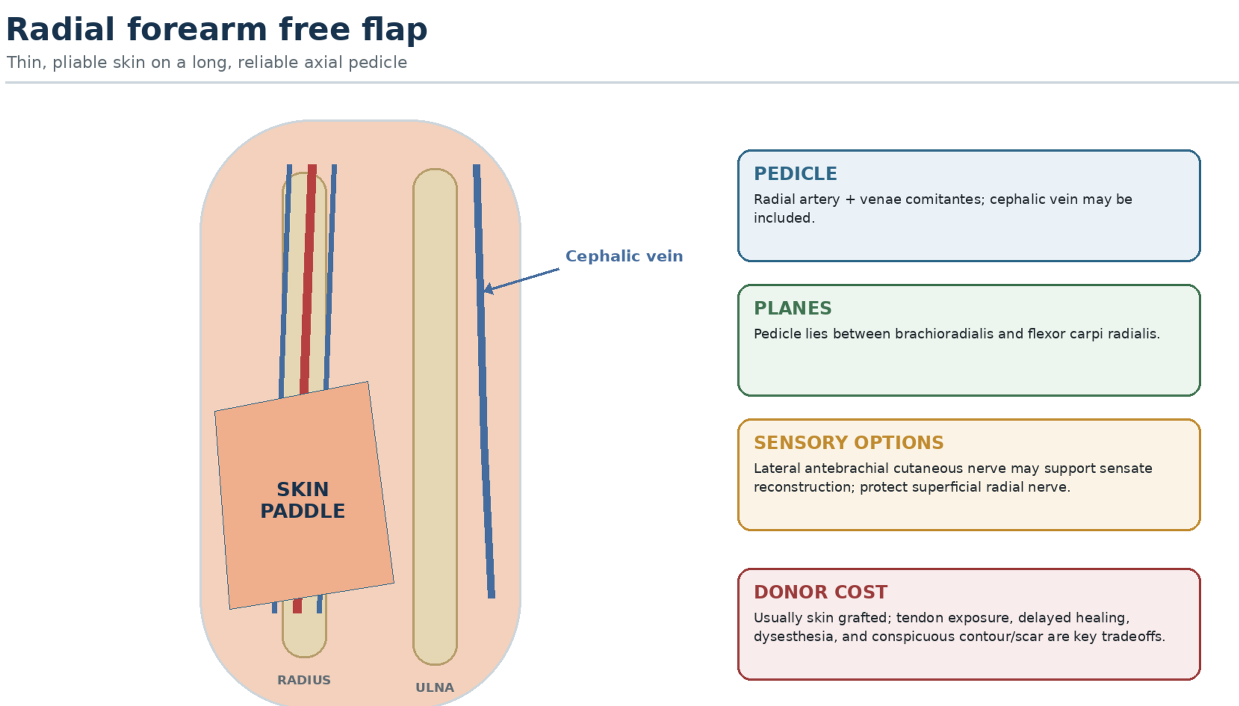


Figure 3. *Conceptual anatomy of the radial forearm free flap. Exact surface markings and dissection sequence vary by surgeon, but the pedicle relationship to brachioradialis and flexor carpi radialis is constant. Original schematic created for this guide.*

What the flap provides

The radial forearm flap is primarily a fasciocutaneous flap. Its defining property is not simply thinness, but thinness combined with pliability, predictable perfusion, a broad design territory, and a long pedicle. Those features allow the skin paddle to fold, tube, or conform around mobile structures without carrying a large subcutaneous burden. It is therefore particularly effective for oral tongue, floor of mouth, buccal mucosa, soft palate, lip, partial pharyngeal, and selected circumferential pharyngoesophageal defects.

The flap can be designed with fascia, palmaris longus tendon, a sensory nerve, or a segment of radius. Each modification should solve a specific problem. Palmaris longus can support a lip or commissure sling. The lateral antebrachial cutaneous nerve can be coapted when sensate reconstruction is desired. An osteocutaneous segment can address a limited bone defect, but its donor-site risk and restricted bone stock make it a secondary osseous option rather than a default substitute for fibula or scapula.

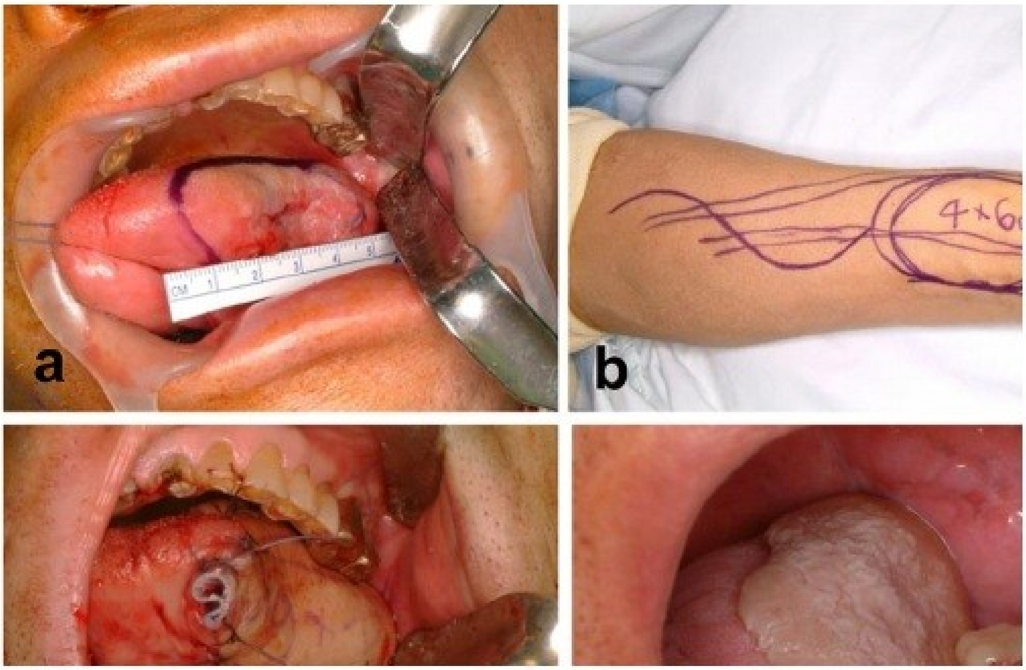


Figure 4. Radial forearm flap used for lateral tongue reconstruction: defect, donor design, inset, and long-term appearance. The case demonstrates the flap's low-volume, pliable profile. Kim et al., Maxillofacial Plastic and Reconstructive Surgery 2020; CC BY 4.0. Cropped from the open-access article.

Vascular anatomy

The radial artery runs in the forearm between brachioradialis laterally and flexor carpi radialis medially, accompanied by two venae comitantes. Numerous septocutaneous branches traverse the deep fascia and supply the overlying skin. The pedicle can be dissected proximally toward the antecubital fossa, where the venae comitantes may communicate with the superficial venous system. The cephalic vein is often included as an additional or alternative venous outflow pathway, depending on flap design and surgeon preference.

The superficial branch of the radial nerve lies in the lateral forearm and is vulnerable during elevation. Injury can produce painful dysesthesia or sensory loss over the dorsoradial hand. The lateral antebrachial cutaneous nerve travels with the cephalic system and may be included intentionally for sensory neurorrhaphy. Tendon paratenon must be preserved whenever possible because exposed tendon accepts a skin graft poorly and is a major driver of donor-site morbidity.

Preoperative assessment

The essential preoperative question is whether the hand will remain adequately perfused after radial artery sacrifice. A modified Allen test is widely taught and remains boards-relevant, but bedside testing is operator dependent. Many programs supplement it with Doppler assessment, pulse oximetry, plethysmography, or a Barbeau-type waveform test. Equivocal findings, prior radial arterial instrumentation, vascular disease, trauma, or discordant pulses warrant a more definitive evaluation or selection of another donor site.

Dominant hand is a preference rather than an absolute prohibition. Many teams favor the nondominant forearm to reduce the perceived functional and cosmetic burden, but oncologic access, recipient-vessel geometry, prior procedures, and patient preference may dictate otherwise. The forearm should be protected from arterial lines, repeated IV trauma, and blood-pressure cuffs once selected as the donor.

CLASSIC CONTRAINDICATION

Inadequate collateral hand perfusion is an absolute reason not to sacrifice the radial artery. Prior surgery, severe scarring, active infection, or major vascular injury may also eliminate the donor.

Harvest concept

The arm is positioned on an arm board, often with a tourniquet. The skin paddle is centered over the radial vascular axis and designed to match the defect rather than to maximize available skin. Dissection proceeds in a plane that preserves the deep fascia with the flap and protects paratenon over the flexor tendons. The pedicle is identified distally and traced proximally between brachioradialis and flexor carpi radialis. Superficial venous and sensory structures are incorporated or preserved according to the plan. Before division, the hand is reassessed with the radial artery occluded.

The resident should understand why careless distal dissection is consequential. The radial artery is close to the superficial radial nerve and the flexor tendons, and a small donor site can become a major wound if paratenon is stripped or the graft bed is desiccated. The harvest is “easy” only when tissue handling is meticulous.

Inset logic and high-yield indications

Thin tissue is most useful when residual native movement should be preserved. In a partial tongue defect, a bulky flap can restrict the remaining tongue and reduce the sulcus. In the floor of mouth, a supple flap can line the defect without creating a fixed mound. In the pharynx, the flap can be fashioned as a patch or tube. For total glossectomy or large dead-space problems, however, the same thinness becomes a liability; the flap may not restore enough bulk for palatal contact or fill a large three-dimensional cavity.

Table 3. *Clinical situations favoring or disfavoring the radial forearm flap.*

RFFF is especially useful when…	Consider another flap when…
The defect needs thin, highly pliable mucosal lining.	Substantial bulk is needed to restore tongue-palate contact or obliterate dead space.
A long pedicle and generous inset freedom are important.	The patient strongly prioritizes avoiding a visible grafted forearm donor site.
A tubed or folded skin construct is needed.	The forearm circulation is abnormal or the radial artery has been compromised.
A sensate flap or tendon sling is useful.	Large vascularized bone is required.
The patient's thigh is excessively thick for the desired reconstruction.	A large skin paddle can be closed primarily at an alternative donor site.

Donor-site morbidity

Most standard radial forearm donor defects require a skin graft. The visible contour defect and color mismatch are often the patient's dominant long-term concerns. Early problems include partial graft loss, tendon exposure, infection, hematoma, and delayed healing. Later problems include stiffness, reduced grip or endurance, cold intolerance, numbness, dysesthesia, and dissatisfaction with appearance. Severe functional loss is uncommon in well-executed harvests, but the donor site is not "free."

Strategies to reduce morbidity include atraumatic paratenon preservation, careful hemostasis, stable graft fixation, negative-pressure dressings in selected protocols, tendon coverage, and thoughtful rehabilitation. Local tissue rearrangement or full-thickness grafting may be used in selected cases, but each closure method has tradeoffs.

BOARDS PEARLS

Radial artery; venae comitantes with optional cephalic vein; thin and pliable; long pedicle; often skin-grafted donor site; lateral antebrachial cutaneous nerve for sensate reconstruction; osteocutaneous variant risks radius fracture.

COMMON ERROR

Calling the radial forearm flap "best for tongue" without specifying the tongue defect. It is excellent for thin partial-tongue lining but may be inadequate for subtotal or total glossectomy when bulk is the functional requirement.

CHAPTER 3

Anterolateral Thigh Flap

The adjustable soft-tissue workhorse

ONE-SENTENCE IDENTITY

The ALT flap is a versatile perforator-based flap that can be harvested thin or bulky and can incorporate fascia lata, vastus lateralis, multiple skin paddles, and sensory nerve, usually with low donor-site morbidity and primary closure.

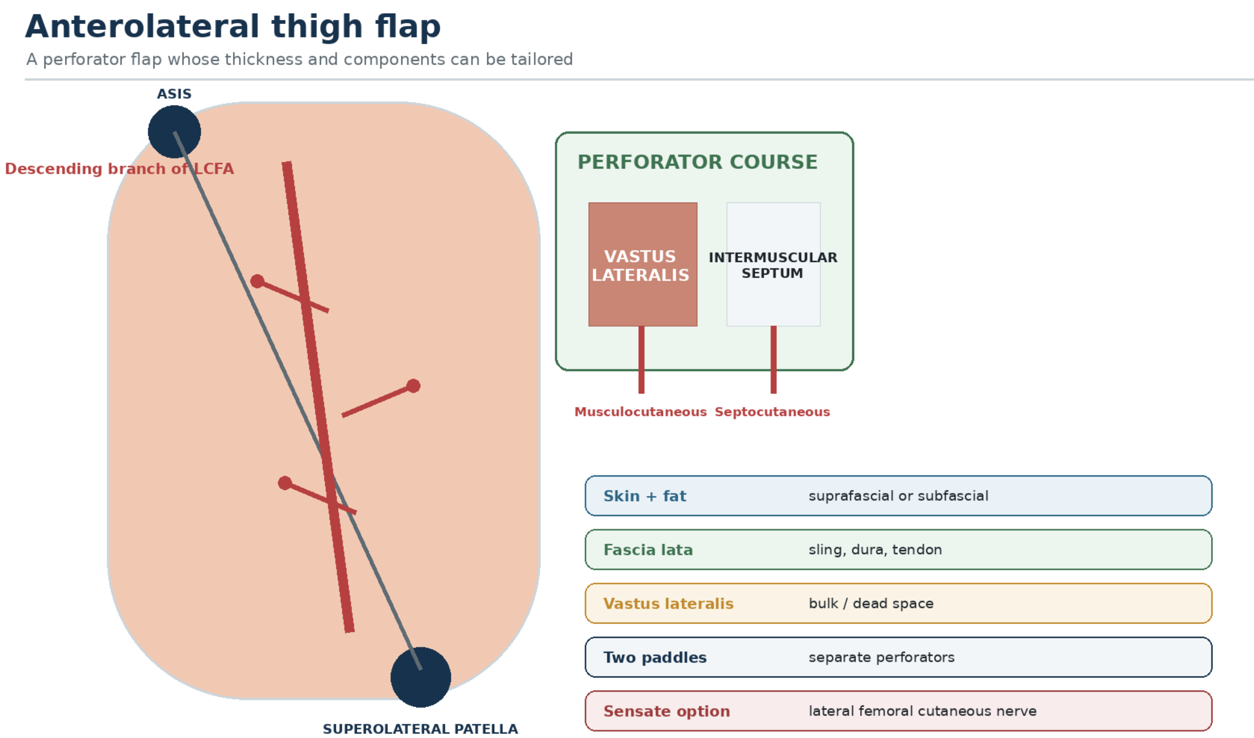


Figure 5. *Conceptual anatomy and component options of the anterolateral thigh flap. Most skin perforators are musculocutaneous rather than purely septocutaneous. Original schematic created for this guide.*

What the flap provides

The ALT occupies a broad middle ground between the thin radial forearm flap and the large muscle-based flaps. Skin and subcutaneous tissue can be elevated above or below the fascia, thinned when appropriate, or augmented with fascia lata and vastus lateralis. The same donor site can therefore provide a thin mucosal patch, a bulky total-glossectomy mound, a large external skin paddle, a folded through-and-through construct, or a chimeric combination of separate tissue components.

This adjustability explains why many high-volume programs regard the ALT as their primary soft-tissue workhorse. The donor scar is usually concealed, the patient can remain supine, the flap can be harvested simultaneously with tumor ablation, and donor function is generally well preserved. The limitations are equally important: perforator anatomy is variable, the flap may be too thick in some patients, thinning requires judgment, and a wide donor defect may still require grafting.

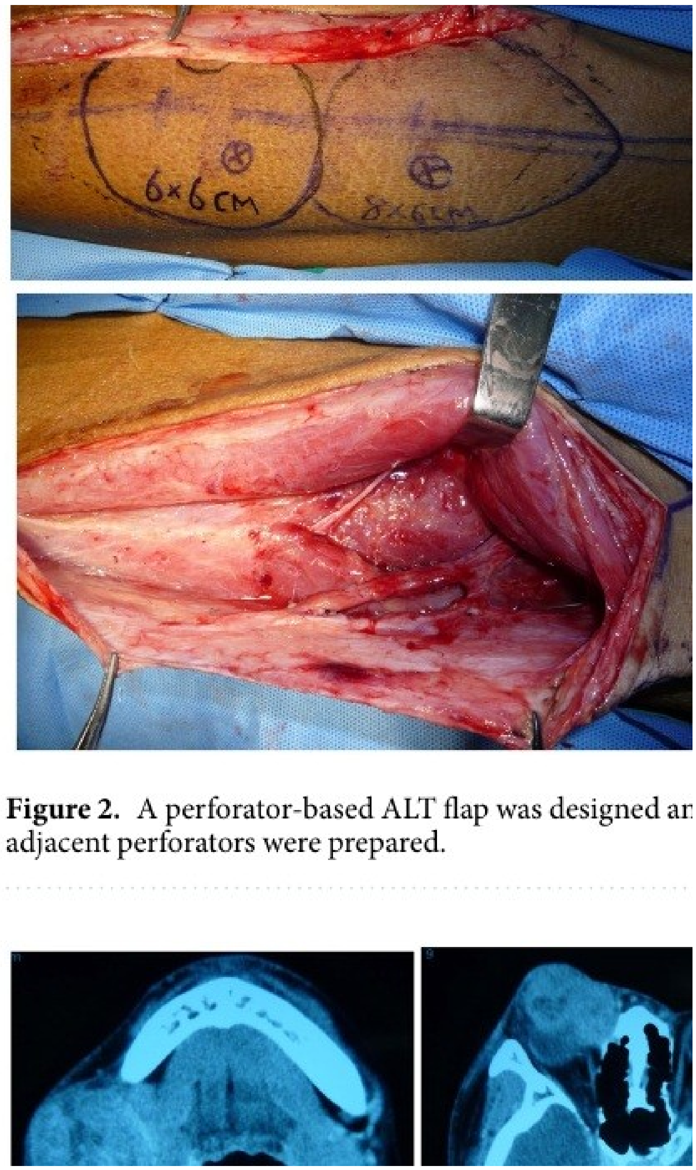


Figure 6. *Perforator-based ALT harvest for a composite defect. The source image demonstrates flap design, perforator dissection, and the ability to tailor separate tissue blocks. Wang et al., Scientific Reports 2020; CC BY 4.0. Cropped from the open-access article.*

Vascular anatomy

The flap is most commonly based on perforators from the descending branch of the lateral circumflex femoral artery, a branch of the profunda femoris system. The descending branch runs in the interval between rectus femoris and vastus lateralis. Cutaneous perforators usually traverse vastus lateralis and less commonly pass through the intermuscular septum. An oblique branch or other variant may supply the dominant perforator.

The perforator course is the operative heart of the flap. A musculocutaneous perforator must be dissected through muscle while preserving its small branches and avoiding injury to the motor nerve to vastus lateralis. When the reconstructive plan permits, a small cuff of muscle can be taken around a difficult perforator rather than skeletonizing it completely. The descending branch can also supply a separate segment of vastus lateralis, enabling a chimeric muscle component.

The lateral femoral cutaneous nerve can be included to create a sensate flap. Fascia lata can be harvested as a vascularized or nonvascularized component for suspension, dural repair, or reinforcement. Multiple perforators may support one large paddle or separate paddles, but the surgeon must confirm that each planned component has an independent and adequate blood supply before division.

Surface planning and perforator mapping

A line from the anterior superior iliac spine to the superolateral patella is the classic surface axis. Dominant perforators frequently cluster near the midpoint, but “frequently” is not “always.” Handheld Doppler is commonly used to map candidates, while CTA is reserved in many centers for unusual anatomy, prior surgery, or complex multi-paddle planning. The operative plan must remain flexible until the perforator is seen.

RESIDENT HABIT

Do not assume the Doppler mark is the perforator that will be used. Know whether the attending plans a suprafascial or subfascial elevation, whether muscle or fascia is required, and what the backup plan is if the dominant perforator is absent or unusable.

Harvest concept

The patient remains supine with the leg prepared widely. A medial or lateral incision is made according to surgeon preference, and the dissection identifies candidate perforators before committing the entire skin paddle. In a subfascial harvest, the fascia is elevated with the flap until the perforator is found. The perforator is then traced through the septum or vastus lateralis to the descending branch. Motor branches are preserved whenever possible. The pedicle is dissected proximally to the desired length, and the exact tissue components are divided only after perfusion and geometry are confirmed.

Flap thinning can occur primarily during harvest, on the back table, or secondarily after healing. Aggressive thinning can injure the subdermal plexus or perforator branches, particularly near the point where the perforator enters the flap. The safe amount of thinning depends on perforator location, flap design, patient adiposity, and surgeon experience. “ALT can be as thin as radial forearm” is possible in selected patients, not a universal guarantee.

Clinical applications

The ALT is particularly effective for subtotal and total glossectomy, large floor-of-mouth defects, through-and-through cheek defects, scalp and skull-base coverage, orbital exenteration cavities, and patch or tubed pharyngeal reconstruction. In tongue reconstruction, bulk should be intentional: enough to restore palatal contact and prevent a dependent trough, but not so much that the residual tongue or pharynx is obstructed. Muscle can fill dead space while a separate skin paddle provides mucosal lining.

A folded ALT can provide internal and external lining in a through-and-through defect. Two independent paddles are preferable when the surfaces are widely separated or require different orientation. The ability to include fascia lata makes the donor particularly useful when a sling or barrier is needed in addition to soft tissue.

Table 4. *ALT versus radial forearm: a boards-relevant and clinically useful comparison.*

Feature	ALT	Radial forearm
Thickness	Variable; may be thin, moderate, or bulky.	Consistently thin and pliable.
Pedicle	Long, good caliber; perforator-dependent.	Long, predictable axial pedicle.
Anatomy	Perforator variability; intramuscular dissection often required.	Relatively constant and straightforward.
Donor closure	Often primary if width is limited; graft if large.	Frequently requires skin graft.
Components	Skin, fat, fascia lata, vastus lateralis, multiple paddles, sensory nerve.	Skin, fascia, tendon, sensory nerve, limited radius.
Best functional niche	Large or three-dimensional soft-tissue defects; adjustable volume.	Thin lining, folding, tubing, and maximum pliability.
Main tradeoff	Thickness and perforator complexity.	Visible donor morbidity and radial artery sacrifice.

Donor-site morbidity

When the donor site is closed primarily and motor nerves are preserved, long-term functional morbidity is usually limited. Early issues include seroma, hematoma, wound dehiscence, infection, and sensory change. Harvest of a large segment of vastus lateralis can cause weakness or gait symptoms, although small muscle cuffs are often well tolerated. Lateral femoral cutaneous nerve harvest creates an expected sensory deficit. Wide skin paddles that require grafting increase wound burden and may delay mobility.

BOARDS PEARLS

Descending branch of the lateral circumflex femoral artery; most perforators are musculocutaneous; can include fascia lata and vastus lateralis; multiple paddles and chimeric designs are possible; donor site often closes primarily. Low donor morbidity does not guarantee appropriate thickness: a bulky ALT can impair oral mobility, airway, or conduit caliber.

CHAPTER 4

Fibula Osteocutaneous Free Flap

The dominant workhorse for long-segment mandibular reconstruction

ONE-SENTENCE IDENTITY

The fibula flap provides a long segment of bicortical vascularized bone that tolerates multiple osteotomies, supports dental implants, and can carry a skin paddle and muscle, while preserving independent ambulation in most appropriately selected patients.

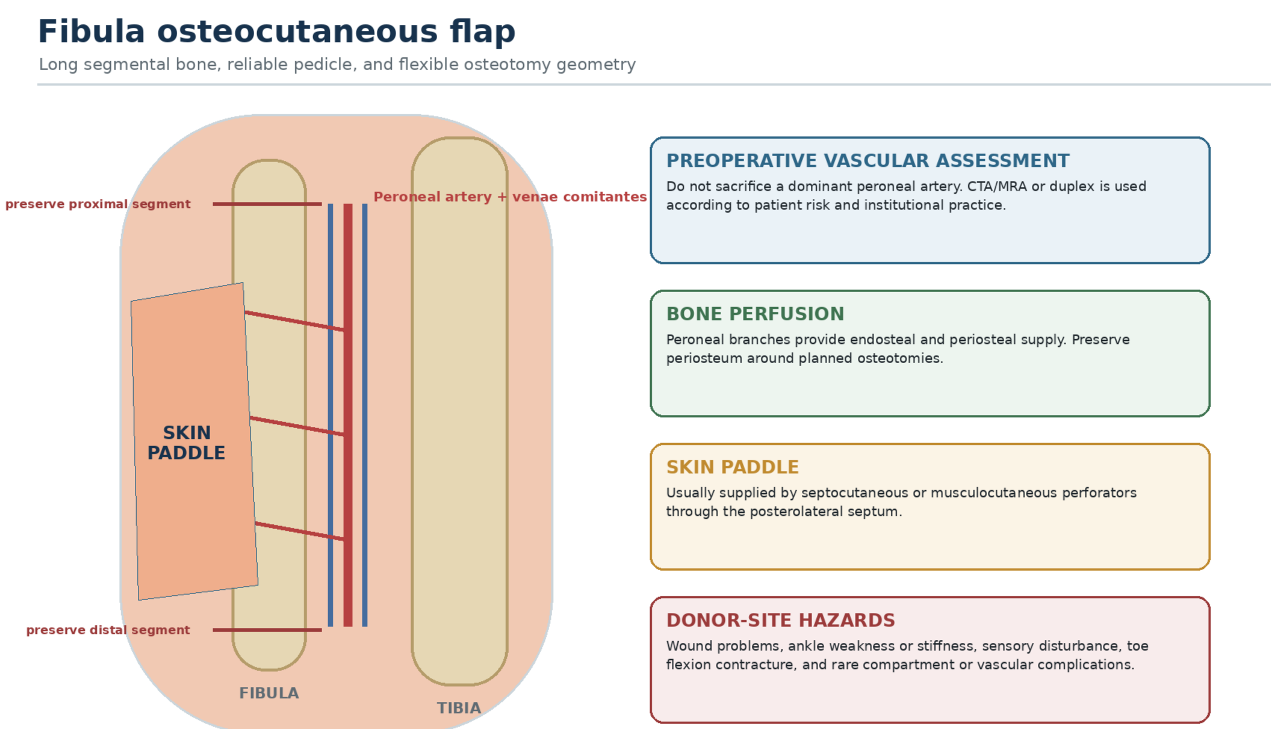


Figure 7. *Conceptual anatomy of the fibula osteocutaneous flap. The peroneal vessels supply bone and skin through periosteal, endosteal, and perforating branches. Original schematic created for this guide.*

Why the fibula became the mandibular workhorse

Mandibular reconstruction requires more than bridging a gap. The graft must tolerate osteotomies, accept fixation, restore an arch, survive radiation, and ideally provide a platform for dental rehabilitation. The fibula satisfies these requirements better than any other donor in the average long segmental defect. It offers a long, relatively straight segment of bicortical bone with a segmental blood supply, allowing multiple closing-wedge osteotomies while maintaining perfusion. The pedicle is long and of suitable caliber, and the skin paddle can replace mucosa or external skin.

Its limitations are geometric and soft-tissue related. The fibula's vertical height is less than that of the native dentate mandible, creating a discrepancy between the inferior border and the future occlusal plane. A double-barrel design, vertical positioning, or patient-specific planning may address this in selected cases. The skin paddle may be bulky, perforators may limit mobility, and a very large soft-tissue defect may exceed what the lower leg can provide without a second flap.

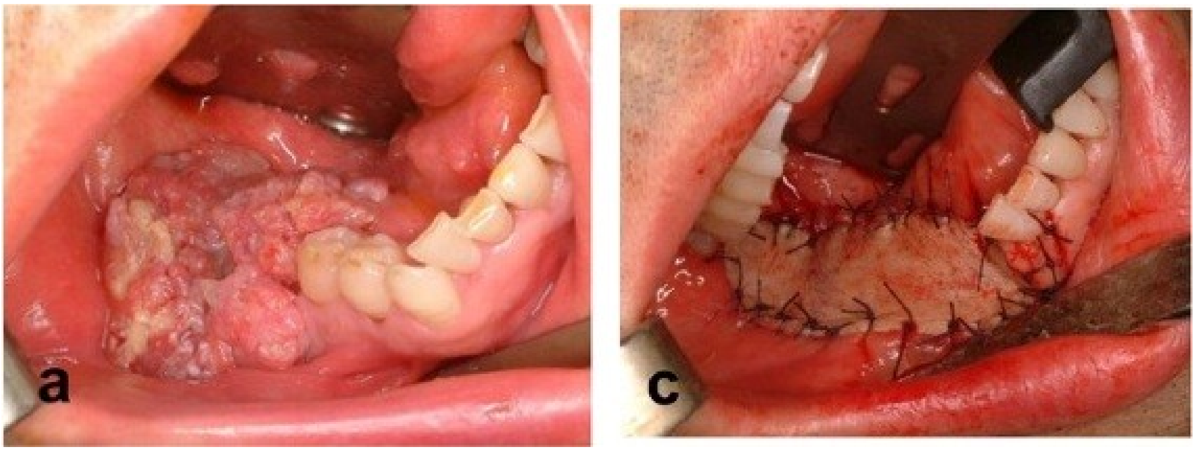


Figure 8. *Oral cavity tumor before resection and a healed intraoral skin-paddle inset after fibula osteocutaneous reconstruction. Kim et al., Maxillofacial Plastic and Reconstructive Surgery 2020; CC BY 4.0. Panels cropped and rearranged from the open-access article.*

Vascular anatomy

The peroneal artery arises from the tibioperoneal trunk and travels in the deep posterior compartment, accompanied by two venae comitantes. It runs close to the posteromedial fibula between tibialis posterior and flexor hallucis longus. Muscular, periosteal, and nutrient branches supply the bone. Cutaneous perforators pass toward the posterolateral skin, most often through the posterior intermuscular septum or adjacent muscle.

The skin paddle is not merely attached to the fibula by soft tissue; it depends on one or more perforators whose location and mobility determine the inset. A paddle based on a single robust perforator may rotate more freely than one tethered by several short perforators. When a large skin requirement is anticipated, perforator anatomy should be incorporated into the design rather than treated as an afterthought.

The common peroneal nerve is at risk proximally near the fibular neck and is protected by preserving a proximal segment. Distally, preservation of the lateral malleolar segment and stabilizing attachments protects ankle stability. Exact safe margins vary by technique and patient size, but a commonly taught principle is to leave approximately 6 cm proximally and distally. The resident should follow the operative team's planned measurements rather than memorize a single universal number.

Preoperative vascular assessment

The catastrophic selection error is harvesting the peroneal artery from a leg in which it is the dominant supply to the foot. Normal palpable pulses reduce but do not eliminate that possibility. Many head and neck programs therefore obtain CTA or MRA routinely before fibula harvest; others use selective imaging based on history, exam, and duplex. The study should be reviewed for three-vessel runoff, stenosis, occlusion, anomalous origin, peroneal dominance, and the quality of the proposed pedicle and perforators.

The clinical exam also matters. Severe peripheral neuropathy, chronic edema, venous disease, prior fracture or hardware, poor skin quality, unstable ankle, major gait impairment, or a limb critical to the patient's mobility may shift the balance toward another osseous donor. Previous lower-extremity trauma can alter perforators even when the major vessels appear patent.

BOARDS PEARL

Peronea arteria magna - a dominant peroneal artery supplying the foot - is a classic contraindication to sacrificing the peroneal system.

Harvest concept

The patient is supine, and the leg is prepared to permit assessment of the foot. A skin paddle is designed over mapped perforators. The lateral compartment is opened, the peroneal muscles are elevated from the fibula, and the intermuscular septa are divided while preserving the selected perforators. A cuff of flexor hallucis longus is commonly left with the pedicle to protect it. Proximal and distal osteotomies are made after the safe segments are confirmed. The pedicle is then dissected toward the tibioperoneal trunk.

Several injuries are preventable by understanding the compartmental anatomy. Excessive traction near the fibular neck risks the common peroneal nerve. Injury to the flexor hallucis longus or its innervation can contribute to great-toe weakness or contracture. Inadequate hemostasis within the deep compartments can produce postoperative pressure and pain. The skin paddle may appear perfused initially despite a damaged perforator; it must be handled as an independent vascular component.

Osteotomies and skin-paddle geometry

Fibular osteotomies create the mandibular shape but also create vascular risk. The periosteum and attached soft tissue around each segment preserve circulation, so stripping should be minimized. The number and location of osteotomies are dictated by the defect, plate, occlusion, and planned dental position. Virtual surgical planning and cutting guides improve geometric reproducibility, but they do not replace direct assessment of pedicle and soft-tissue geometry.

The skin paddle's relation to the bone must be planned before the osteotomies are finalized. A perfectly shaped bone can still be unusable if the paddle cannot reach the floor of mouth without twisting its perforators. Conversely, a soft-tissue inset that appears easy before plating may become tight once the bone is fixed. Bone, skin, and pedicle must be planned as one three-dimensional construct.

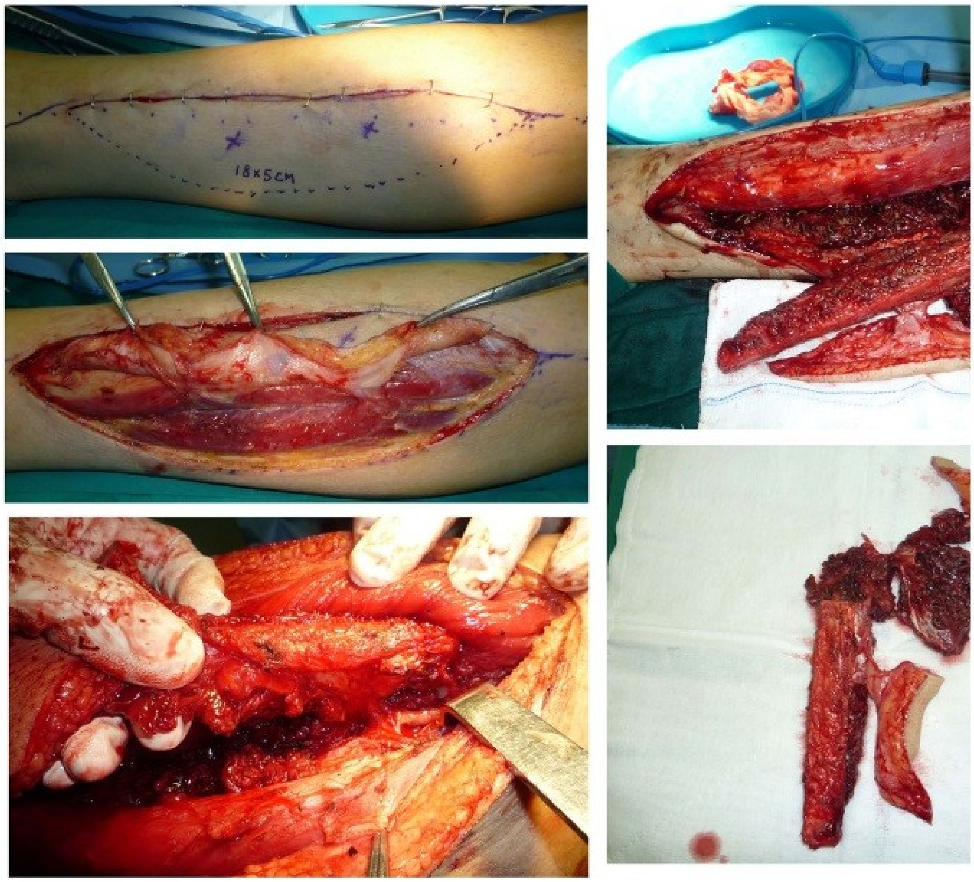


Figure 9. *Chimeric fibula design with multiple soft-tissue components and vascularized bone. The case illustrates how perforator and muscle branches can solve spatially separated requirements. Wang et al., Scientific Reports 2020; CC BY 4.0. Cropped from the open-access article.*

Dental rehabilitation

Fibular bone is bicortical and generally suitable for endosseous implants. Implant planning is most successful when prosthodontic goals influence the reconstruction from the beginning. The bone must be placed in a position that supports the future occlusal plane, not merely along the native inferior mandibular border. Immediate implants and immediate or early prosthetic workflows are increasingly used in selected centers, while delayed implantation remains common. On boards, the key point is that the fibula provides excellent bone length and implantable stock, but its native vertical height is limited relative to the dentate mandible.

Donor-site morbidity

Early donor complications include wound dehiscence, graft loss when the donor is skin-grafted, infection, hematoma, compartment problems, and vascular compromise of the foot. Longer-term issues include ankle stiffness or weakness, altered gait, sensory changes, great-toe weakness or clawing, chronic pain, and contour change. Most appropriately selected patients ambulate independently, but subtle deficits may matter greatly to athletes, patients with contralateral limb disease, or those whose occupation depends on lower-extremity performance.

Table 5. *Why the fibula is the usual first osseous workhorse.*

Fibula strength	Clinical consequence
Long bone segment	Suitable for body-to-body or larger mandibular defects and multiple osteotomies.
Segmental vascularity	Permits contouring while maintaining bone perfusion when periosteal attachments are preserved.
Bicortical stock	Supports rigid fixation and dental implants.
Long pedicle	Usually reaches standard neck recipient vessels without grafting.
Skin paddle and muscle options	Allows simultaneous lining, cover, or dead-space reconstruction.
Two-team supine harvest	Efficient for major oncologic ablation.

BOARDS PEARLS

Peroneal artery and venae comitantes; long bicortical bone; multiple osteotomies; dental implants; preserve proximal and distal fibular segments; evaluate runoff and exclude peroneal-dominant circulation.

COMMON ERROR

Interpreting a normal pulse examination as sufficient vascular clearance in a high-risk patient. Major-vessel patency, anatomic dominance, and donor-site function are separate questions.

CHAPTER 5

The Subscapular System

Scapular, parascapular, scapular-tip, latissimus, serratus, and chimeric combinations

ONE-SENTENCE IDENTITY

The subscapular system is the most versatile multi-component donor platform, capable of providing independently mobile skin, muscle, fascia, rib, lateral scapular border, and scapular-tip bone on a common source system.

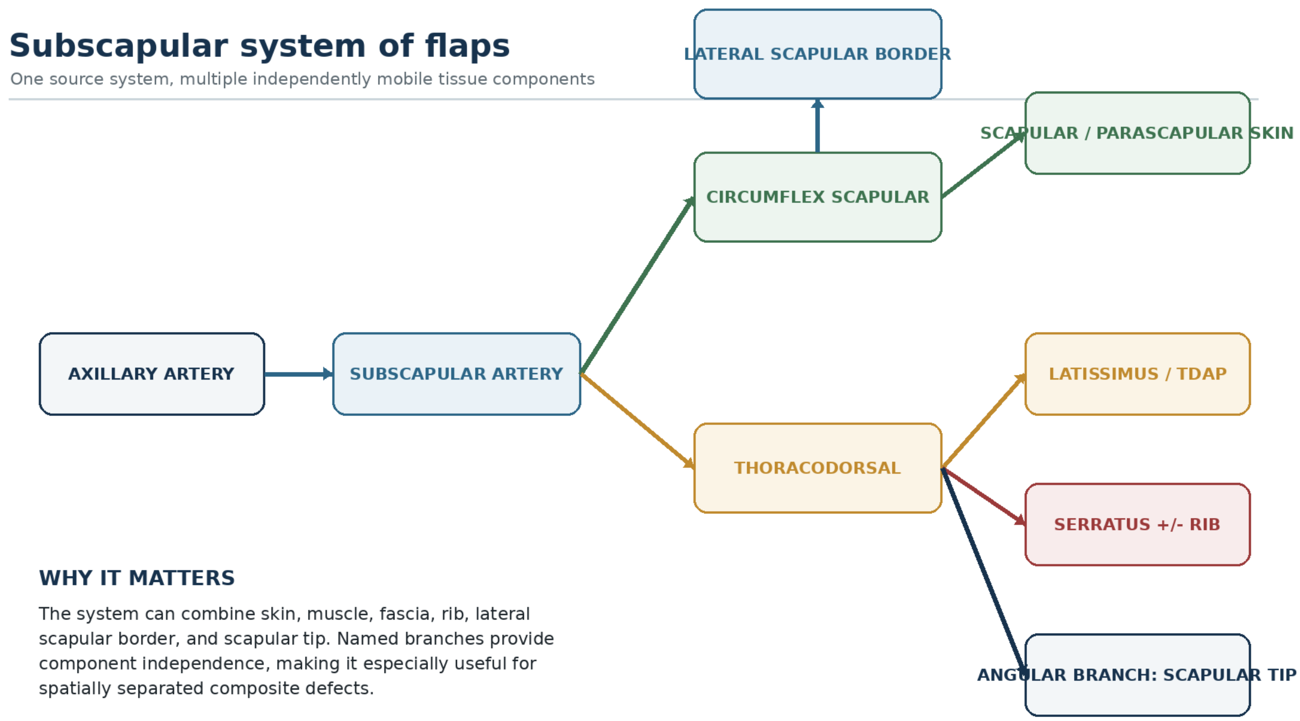


Figure 10. *The subscapular vascular tree and its major reconstructive components. Branch anatomy permits numerous chimeric combinations. Original schematic created for this guide.*

Vascular organization

The subscapular artery arises from the axillary artery and divides into the circumflex scapular and thoracodorsal systems. The circumflex scapular artery passes through the triangular space and supplies scapular and parascapular skin as well as the lateral scapular border. The thoracodorsal artery supplies latissimus dorsi and gives branches to serratus anterior and, through the angular branch, the scapular tip. These branches can be harvested separately or in combination.

The practical advantage is component independence. A skin paddle can be rotated to line the oral cavity while a muscle component fills the neck and a bone segment reconstructs the maxilla. The components are not forced to remain in the same plane. This freedom is especially useful for through-and-through defects, maxillectomy defects with orbital and palatal requirements, and reconstructions in which a single osteocutaneous flap would tether the soft tissue to the bone.

Scapular and parascapular skin flaps

Scapular and parascapular flaps are fasciocutaneous flaps based on the circumflex scapular system. They provide broad, durable skin with a donor scar hidden on the back and generally low functional morbidity. The skin is often thicker than radial forearm tissue and may be less suited to a narrow oral cavity. Pedicle length from the circumflex scapular system is shorter than that of the angular-branch scapular-tip construct, although dissection toward the subscapular origin can increase available length.

The skin paddles can be oriented transversely or longitudinally according to the cutaneous branch. They are particularly attractive when a large external skin surface is needed and color or texture is acceptable. Primary closure depends on paddle width and patient laxity.

Lateral scapular border and scapular-tip bone

The lateral scapular border provides a straight segment of vascularized bone supplied by the circumflex scapular artery. It can reconstruct short mandibular segments and can be combined with scapular or parascapular skin. The scapular tip, supplied by the angular branch of the thoracodorsal system, has a triangular geometry that resembles portions of the mandibular angle, palate, and maxilla. Its longer pedicle and three-dimensional shape make it especially useful for selected maxillary and posterior mandibular defects.

Compared with fibula, scapular bone offers less total length and usually less uniform implant-bearing stock, but the soft-tissue options are far more flexible. The donor may also be preferable in patients with lower-extremity vascular disease or when early ambulation is a priority. Dental rehabilitation is possible in selected scapular reconstructions, but bone thickness and orientation must be evaluated case by case.

Latissimus dorsi and thoracodorsal artery perforator components

Latissimus dorsi provides a very large, reliable muscle with or without a skin paddle. It is useful for extensive scalp, skull-base, facial, and composite defects requiring robust vascularized coverage and dead-space obliteration. Denervated muscle atrophies over time, so the surgeon should distinguish between temporary postoperative bulk and durable volume. A thoracodorsal artery perforator flap can provide skin and fat while sparing most of the muscle, but perforator dissection is more demanding.

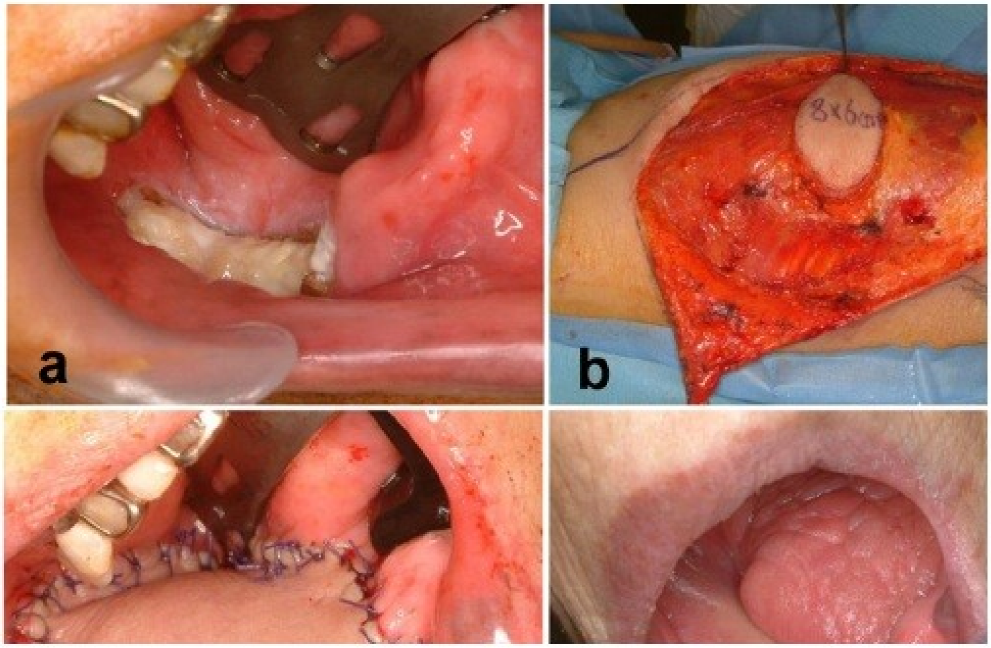


Figure 11. Latissimus dorsi free flap used for a large oral and maxillofacial defect. Muscle provides broad vascularized coverage and dead-space control. Kim et al., Maxillofacial Plastic and Reconstructive Surgery 2020; CC BY 4.0. Cropped from the open-access article.

Serratus anterior and rib

Branches of the thoracodorsal system supply slips of serratus anterior and can support an attached rib segment. Serratus is thin, pliable muscle that can cover exposed vessels, dura, or hardware with less bulk than latissimus. Rib can provide a modest osseous component, but its geometry and structural properties make it a specialized option rather than a routine substitute for fibula or scapular bone.

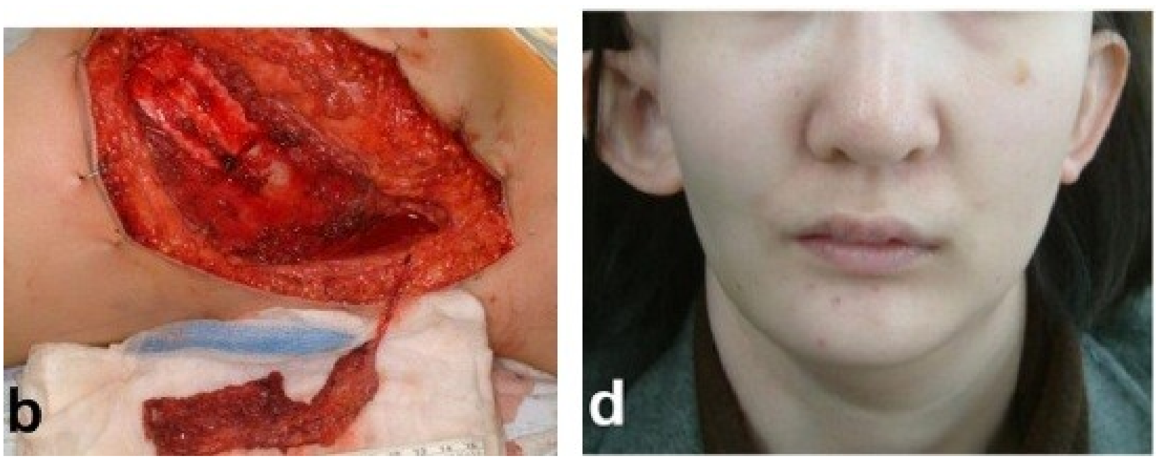


Figure 12. Serratus anterior with rib component in a complex maxillofacial reconstruction. Operative donor-site view and postoperative facial result illustrate a specialized thin-muscle and bone construct. Kim et al., Maxillofacial Plastic and Reconstructive Surgery 2020; CC BY 4.0. Panels cropped and rearranged from the open-access article.

Positioning and harvest logistics

Traditional harvest in the lateral decubitus position can complicate simultaneous ablation and may require repositioning. Modified semilateral or supine approaches, including ventral access to the angular and thoracodorsal branches, permit two-team surgery in experienced hands. The position must be planned before induction because it affects neck access, arm placement, pressure points, and the ability to convert to another donor site.

Shoulder function is generally preserved when muscle and nerve injury are minimized, but the donor is not functionally neutral. Latissimus harvest may affect shoulder extension, adduction, or internal rotation, and scapular bone harvest may cause pain, weakness, winging, or reduced range of motion. Prior axillary surgery or radiation can compromise the source system.

Table 6. *The subscapular system as a menu of components.*

Subscapular component	Best use	Key limitation
Scapular/parascapular skin	Large skin surface; external cover; hidden donor scar.	Thickness; traditional positioning; circumflex-scapular pedicle may be shorter.
Lateral scapular border	Short mandibular bone with skin options.	Limited length and implant geometry compared with fibula.
Scapular tip	Maxilla, palate, mandibular angle, complex 3-D defects.	Triangular bone; planning and harvest complexity.
Latissimus dorsi	Large bulk, scalp/skull base, vessel or hardware coverage.	Denervation atrophy; shoulder morbidity; may be excessive for oral lining.
TDAP	Large skin/fat with muscle preservation.	Perforator dissection and variable anatomy.
Serratus +/- rib	Thin muscle coverage; selected small osseous need.	Limited bone strength and specialized indications.

BOARDS PEARLS

Subscapular artery -> circumflex scapular and thoracodorsal systems. Scapular/parascapular skin is based on circumflex scapular vessels; latissimus, serratus, and angular-branch scapular tip arise from the thoracodorsal system.

COMMON ERROR

Treating “scapula flap” as a single construct. The lateral border, scapular tip, skin paddles, latissimus, serratus, and rib have different pedicles, geometries, and indications.

CHAPTER 6

Other Osseous Workhorses

DCIA, osteocutaneous radial forearm, and when bone geometry changes the answer

Deep circumflex iliac artery flap

ONE-SENTENCE IDENTITY

The DCIA flap provides curved, vertically substantial corticocancellous iliac bone with excellent implant stock and an internal-oblique soft-tissue option, but has a shorter pedicle and a more consequential abdominal-wall donor site.

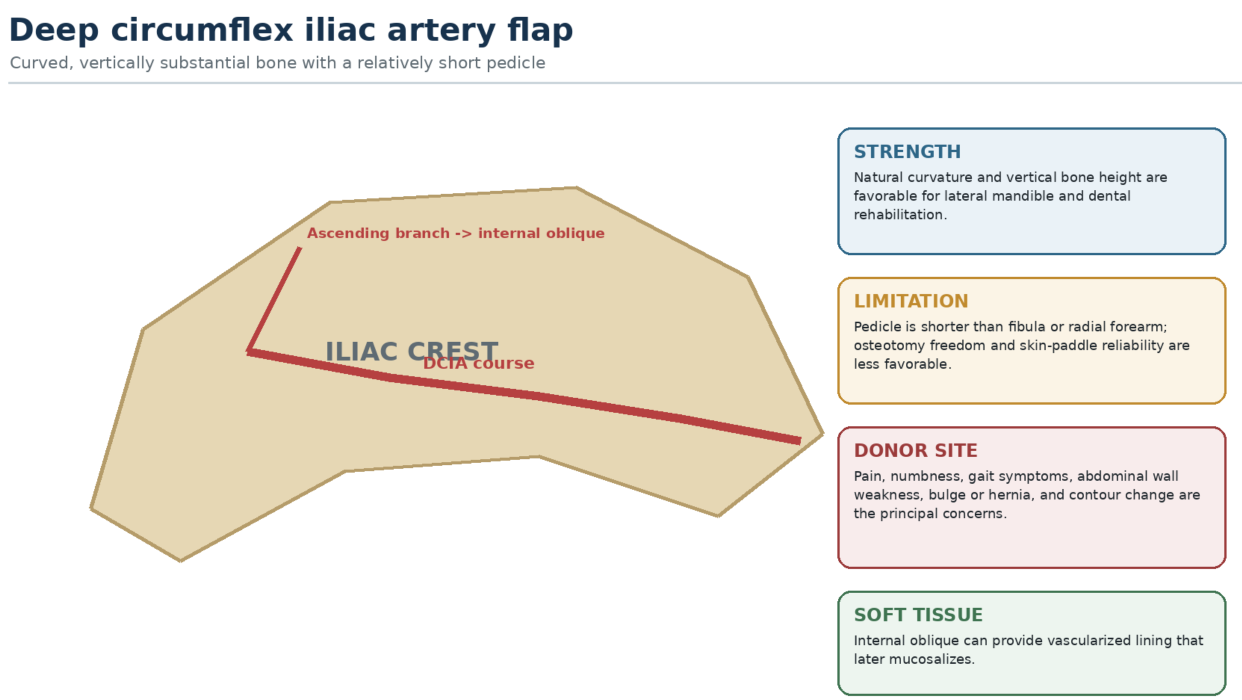


Figure 13. Conceptual anatomy of the DCIA iliac-crest flap and internal-oblique component. Original schematic created for this guide.

The deep circumflex iliac artery arises from the external iliac artery and courses laterally along the inner aspect of the iliac crest. A robust periosteal blood supply supports the harvested bone. An ascending branch supplies internal oblique muscle, which can be transferred as a vascularized soft-tissue component and allowed to mucosalize when inset into the oral cavity.

The iliac crest's natural curvature and vertical height make it attractive for lateral mandibular and selected maxillary reconstruction. The corticocancellous stock is favorable for dental implants and can reproduce mandibular height more closely than a single-barrel fibula. The price is less osteotomy freedom, a shorter pedicle, limited and sometimes unreliable skin, and a donor site that can affect the abdominal wall and gait.

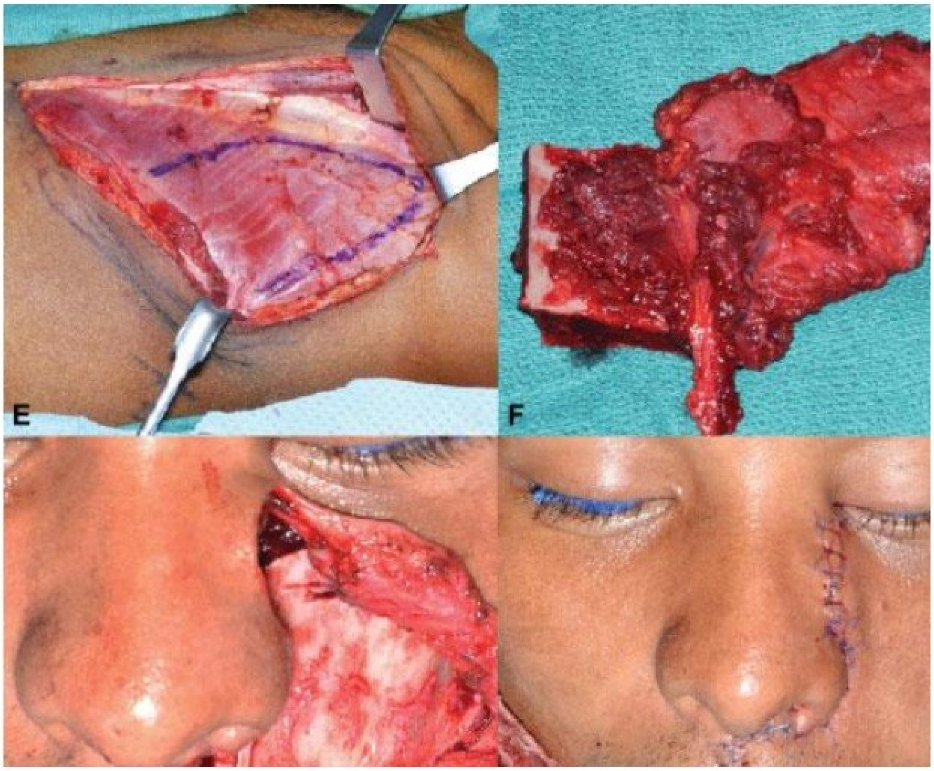


Figure 14. *DCIA-based osteomusculocutaneous reconstruction of a maxillary defect. Iliac bone provides height and contour while internal oblique supplies vascularized lining. Vincent et al., Seminars in Plastic Surgery 2019. Cropped from the publicly accessible article PDF.*

Harvest logic

The incision parallels the iliac crest, and the abdominal wall layers are divided or reflected to expose the inner table and vascular pedicle. The planned bone segment may be bicortical or unicortical. The ascending branch and internal oblique are included when soft tissue is required. The surgeon must protect the lateral femoral cutaneous nerve, preserve abdominal-wall integrity, and avoid injury to intraperitoneal structures. The relatively short pedicle makes preoperative recipient-vessel planning important.

Donor-site morbidity

Pain and temporary gait change are common early concerns. Longer-term complications include numbness, contour deformity, abdominal-wall weakness, bulge or hernia, and chronic hip or groin symptoms. Meticulous fascial closure is central to prevention. A history of major lower-abdominal surgery, hernia, or iliac-crest harvest may make the donor less attractive.

Table 7. *Clinical niches for the DCIA flap.*

When DCIA is attractive	Why
Lateral mandibular defect with dental goals	Natural curvature and high-quality vertical bone stock.
Need for corticocancellous bone	Substantial cancellous component favors union and implant planning.
Need for vascularized muscle lining	Internal oblique can line oral or palatal defects and later mucosalize.

When DCIA is attractive	Why
Lower-leg donor is unavailable	Avoids fibula harvest in vascular disease or prior leg trauma.

BOARDS PEARLS

Source: deep circumflex iliac artery from the external iliac system. Strengths: natural curvature, bone height, dental implant stock. Weaknesses: shorter pedicle, limited skin, abdominal-wall morbidity and hernia risk.

Osteocutaneous radial forearm free flap

The osteocutaneous radial forearm free flap adds a partial-thickness segment of radius to the familiar thin skin paddle and long pedicle. It can be useful for limited segmental bone loss when the soft-tissue requirement strongly favors radial forearm tissue and only modest bone stock is needed. Typical examples include selected lateral mandibular, maxillary, or orbital-rim defects.

Its major limitation is donor radius fracture. Modern harvest uses a carefully shaped partial-thickness segment and prophylactic plate fixation to reduce this risk. Even with fixation, the available bone length and height are less than fibula or DCIA, and the donor still carries the skin-grafted forearm morbidity. It should be viewed as a specialized combined solution, not as a smaller fibula.

BOARDS PEARL

The osteocutaneous radial forearm flap offers thin skin and a long pedicle with limited bone. Prophylactic radius plating is used because pathologic fracture is the classic donor-site complication.

Medial femoral condyle and other vascularized bone options

The medial femoral condyle flap provides thin corticoperiosteal or corticocancellous vascularized bone and can be configured with skin or muscle. It is highly useful in nonunion, small craniofacial defects, and salvage settings where biologically active bone is more important than long structural stock. Its role in routine primary mandibular reconstruction is limited by bone size and structural capacity.

Rib, metatarsal, and other osseous flaps appear in specialized reconstructive literature. For boards, the practical comparison remains fibula versus scapular system versus DCIA versus osteocutaneous radial forearm. Less common donors are chosen when those workhorses cannot match a specific geometry or when prior harvest and vascular disease have narrowed the options.

Table 8. *Comparison of vascularized osseous donor sites.*

Osseous flap	Bone length/shape	Soft-tissue flexibility	Pedicle	Donor-site headline
Fibula	Longest; straight; multiple osteotomies.	Skin paddle +/- muscle; moderate flexibility.	Long.	Lower-leg wound, ankle/gait, vascular selection.

Osseous flap	Bone length/shape	Soft-tissue flexibility	Pedicle	Donor-site headline
Scapular system	Shorter; lateral border or triangular tip.	Excellent; independent skin and muscle components.	Variable; angular branch relatively long.	Shoulder function and positioning.
DCIA	Curved, tall corticocancellous bone.	Internal oblique useful; skin less favorable.	Shorter.	Pain, gait, bulge or hernia.
OCRFFF	Limited partial radius.	Excellent thin skin and long pedicle.	Long.	Skin-grafted forearm and radius fracture risk.
Medial femoral condyle	Small biologically active bone.	Optional skin/muscle; specialized.	Moderate.	Knee symptoms; limited structural stock.

Bone-donor selection in one minute

Start with the geometry and length of bone, then ask whether the soft-tissue components can move where they are needed. Fibula dominates long, osteotomy-heavy mandibular defects. The subscapular system becomes attractive when independently mobile soft tissue or a three-dimensional maxillary component matters more than maximal bone length. DCIA is strongest when vertical height, curvature, and implant stock are priorities. OCRFFF is a niche solution when thin radial-forearm skin and only limited bone are required.

BOARDS SYNTHESIS

Long straight bone and multiple osteotomies: fibula. Maximum chimeric freedom: subscapular system. Tall curved corticocancellous bone: DCIA. Thin skin plus limited bone and long pedicle: OCRFFF. Small biologically active salvage bone: medial femoral condyle.

CHAPTER 7

Flaps for Bulk, Coverage, and Dead Space

Latissimus, rectus/DIEP, serratus, gracilis, and why muscle behaves differently from fat

A large mucosal surface and a large three-dimensional cavity are not the same defect. Fasciocutaneous flaps excel at lining, but muscle may be superior when the dominant requirement is to fill an infected or irradiated space, cover exposed vessels or hardware, or provide a broad vascular bed beneath a skin graft. Muscle conforms intimately to irregular surfaces and delivers robust perfusion. It also denervates and atrophies, which can be an advantage or a liability.

Latissimus dorsi

The latissimus is supplied by the thoracodorsal vessels and can be harvested as muscle, myocutaneous tissue, or part of a chimeric subscapular construct. It provides one of the largest reliable tissue volumes in the body. Common head and neck applications include major scalp defects, skull-base or temporal-bone cavities, orbital and facial defects, carotid or hardware coverage, and salvage after prior flap failure.

The thoracodorsal nerve may be divided when a static flap is intended. Progressive denervation atrophy reduces long-term bulk, which should be anticipated when contour support is essential. Shoulder morbidity is usually modest but can be meaningful in patients who rely on crutches, wheelchairs, climbing, swimming, or overhead work.

Rectus abdominis, DIEP, and abdominal-based tissue

The rectus abdominis musculocutaneous flap is based on the deep inferior epigastric system and supplies a large skin paddle with substantial muscle and fat. It historically played a major role in total glossectomy, skull-base, and massive soft-tissue reconstruction. Its disadvantages include abdominal-wall morbidity, muscle sacrifice, bulk, and a shift toward muscle-sparing perforator options.

A deep inferior epigastric perforator flap transfers abdominal skin and fat while preserving most rectus muscle. It can provide a large, soft volume with a concealed donor scar and is useful when ALT volume is insufficient or thigh anatomy is unfavorable. Perforator dissection is complex, patient habitus strongly affects flap thickness, and prior abdominal surgery may alter the vascular anatomy. These flaps are less common in routine head and neck practice than ALT but remain valuable in selected high-volume reconstructions.

Serratus anterior

Serratus anterior is a thin, broad muscle supplied by branches of the thoracodorsal system. One or more slips can be harvested, limiting donor morbidity. The muscle is useful for skull-base coverage, vessel protection, small-to-moderate dead-space obliteration, and a vascular bed for skin grafting. Injury to the long thoracic nerve or excessive muscle harvest can produce scapular winging, so branch anatomy and nerve preservation are central.

Gracilis

Gracilis is a smaller muscle based on the medial circumflex femoral system. It is expendable, has a reliable motor nerve, and can be used as a functional muscle transfer for facial reanimation or as a compact soft-tissue flap. Its limited bulk and skin-paddle reliability restrict its role in major oncologic defects, but it can be useful in focused salvage and dynamic reconstruction.

Table 9. *How tissue type changes reconstructive behavior over time.*

Tissue choice	Immediate behavior	Long-term behavior	Best use
Muscle	Conforms to irregular space; robust perfusion; often edematous.	Denervation atrophy and fibrosis, especially after radiation.	Dead space, exposed vessels/hardware, infected or irradiated cavity.
Fasciocutaneous	Stable surface and measurable thickness.	Fat may atrophy but generally retains shape better than muscle.	Mucosal lining, external skin, folded or tubed constructs.
Adipofascial/perforator	Pliable vascularized fat and fascia without skin.	Volume may change with weight and radiation.	Contour, barrier, buried coverage when no skin surface is needed.
Myocutaneous	Muscle plus a monitorable skin paddle.	Skin survives while muscle often loses volume.	Large composite soft-tissue defects and salvage coverage.

BOARDS PEARL

Muscle is valuable for contaminated dead space and protection of exposed vital structures, but denervated muscle loses volume. A flap chosen for long-term tongue bulk or facial contour must account for that atrophy.

CHAPTER 8

Free Jejunal Transfer and Tubular Reconstruction

When native bowel competes with tubed skin

ONE-SENTENCE IDENTITY

The free jejunal flap supplies a lubricated, vascularized intestinal tube closely matched to the cervical esophagus, with strong swallowing outcomes in experienced centers but an abdominal operation, ischemia-sensitive mucosa, and monitoring challenges.

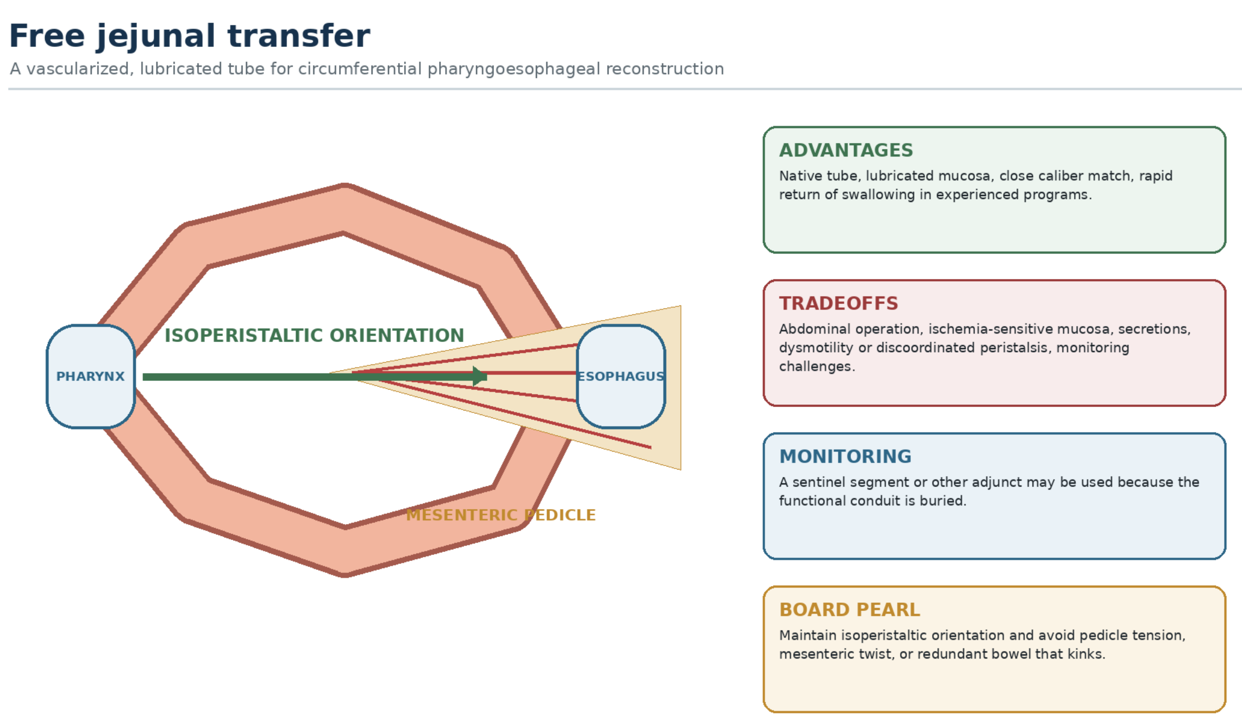


Figure 15. *Conceptual free jejunal reconstruction. The bowel segment is oriented isoperistaltically and transferred with its mesenteric vascular pedicle. Original schematic created for this guide.*

What the flap provides

The jejunum is a ready-made tube with mucosa, muscular wall, and intrinsic peristaltic activity. It is best suited to circumferential pharyngoesophageal defects after total laryngopharyngectomy or resection of the cervical esophagus. The caliber is usually compatible with the esophagus, and the lubricated surface permits early bolus transit. The segment is harvested with a mesenteric arterial and venous arcade and reanastomosed in the neck.

The construct must be oriented isoperistaltically: the native direction of bowel propulsion should run from pharynx toward esophagus. Peristalsis is not neurologically coordinated with the reconstructed pharyngeal swallow, but reverse orientation can worsen transport. Redundant bowel can kink, while excessive tension can narrow the anastomoses or compromise the mesentery.

Harvest and inset concept

A general or reconstructive surgeon identifies a suitable jejunal segment and mesenteric vascular arcade. The bowel is divided, the intestinal continuity is restored in the abdomen, and the flap is transferred to the neck. The proximal lumen may require tailoring to address the larger pharyngeal opening. The mesentery must reach the recipient vessels without twist or compression. Ischemia time is important because jejunal mucosa is less tolerant of prolonged ischemia than skin.

The flap is buried, so monitoring is more difficult than with an external skin paddle. Some teams exteriorize a small sentinel segment, use implantable Doppler or flow monitoring, or rely on endoscopic assessment and clinical changes. A sentinel must share relevant vascular supply without creating its own torsion or leak risk.

Jejunum versus tubed fasciocutaneous flap

Tubed radial forearm and ALT flaps avoid laparotomy and allow an external monitor paddle, but the surgeon must create a longitudinal seam and proximal and distal anastomoses. The seam can become a fistula or stricture. Skin tubes may be hair-bearing, secrete keratin, and lack lubrication, although careful design yields excellent function. ALT provides more tissue for vessel coverage and neck dead space; radial forearm is thinner and easier to tube but has greater forearm donor morbidity.

Jejunum removes the longitudinal skin-tube seam and offers a native mucosal surface. Its disadvantages include abdominal morbidity, enteric secretions, dysmotility, ischemia sensitivity, and the need for a coordinated abdominal team. Comparative studies do not establish a universal winner. Institutional experience, patient comorbidity, defect level, need for soft-tissue coverage, and speech strategy determine the choice.

Table 10. *Jejunal versus fasciocutaneous pharyngoesophageal reconstruction.*

Feature	Free jejunum	Tubed ALT	Tubed radial forearm
Lumen	Native bowel tube; lubricated mucosa.	Constructed skin tube; adjustable diameter.	Constructed thin skin tube.
Donor operation	Abdominal surgery with bowel anastomosis.	Thigh; usually primary closure if size permits.	Forearm; commonly skin grafted.
Monitoring	Buried; sentinel or adjunct often needed.	External paddle can be designed.	External paddle can be designed.
Soft-tissue coverage	Limited beyond mesentery.	Can include bulk/muscle for neck coverage.	Limited bulk.
Major risks	Bowel/abdominal complications, ischemia-sensitive mucosa, dysmotility.	Fistula/stricture along seam, bulk, donor wound.	Fistula/stricture, donor morbidity, limited bulk.
Typical niche	Circumferential cervical pharyngoesophagus in experienced centers.	Circumferential or near-circumferential defect with soft-tissue need.	Thin tube when forearm tissue is acceptable.

Donor-site morbidity

Potential abdominal complications include ileus, obstruction, leak, wound infection or dehiscence, hernia, and cardiopulmonary consequences of laparotomy. In experienced series, serious donor complications are uncommon, but they can be consequential in frail head and neck cancer patients. Prior abdominal surgery is not an absolute contraindication, although adhesions and altered anatomy may increase difficulty.

BOARDS PEARLS

Free jejunum is a visceral flap for circumferential pharyngoesophageal reconstruction. Maintain isoperistaltic orientation. Advantages are a native lubricated tube and favorable swallowing; disadvantages are laparotomy, buried monitoring, secretions, and ischemia-sensitive mucosa.

COMMON ERROR

Choosing the conduit without considering the neck. A patient with exposed carotid, major irradiated dead space, or a large external skin defect may need more soft tissue than jejunum alone provides.

CHAPTER 9

Secondary and Rescue Donor Sites

Ulnar forearm, lateral arm, PAP, omentum, and what to do when the workhorse is unavailable

The workhorse flaps solve most defects, but prior harvest, vascular disease, trauma, body habitus, donor-site preference, or unusual geometry can make the standard choice impossible. The safe reconstructive surgeon knows several alternatives and understands what is lost when moving away from the familiar donor.

Ulnar forearm free flap

The ulnar forearm flap is a thin fasciocutaneous alternative based on the ulnar artery. It can provide pliable tissue with a concealed medial forearm donor site and may have less visible contour deformity. The ulnar artery is often the dominant contributor to the hand, however, so collateral assessment is at least as important as for the radial forearm. The ulnar nerve lies nearby and must be protected. Many surgeons have less familiarity with the harvest, which affects its practical availability.

Lateral arm flap

The lateral arm flap is based on the posterior radial collateral artery and provides a relatively thin skin paddle from the lateral upper arm. It avoids sacrifice of a major artery to the hand and often permits primary closure. Pedicle length and paddle size are more limited than radial forearm or ALT, and the radial nerve is in the operative field. It is useful for small-to-moderate oral or external defects when a thin donor is desired.

Profunda artery perforator flap

The profunda artery perforator flap harvests skin and fat from the posterior thigh on perforators from the profunda femoris system. It offers a concealed scar and can provide substantial soft tissue with preservation of the lateral thigh. In head and neck reconstruction it is an emerging alternative when ALT perforators are absent, the ALT is too thin or previously harvested, or donor-site preference favors the posterior thigh. Positioning and perforator anatomy can complicate a two-team approach.

Omentum

The omental free flap provides a large, highly vascular, immunologically active sheet that conforms to complex surfaces. It is particularly useful for infected or irradiated skull-base and scalp defects, coverage of exposed vessels, and obliteration of irregular cavities. It requires an abdominal operation and usually a skin graft when used externally. Long-term contour can be unpredictable, and abdominal complications must be considered.

Thoracoacromial and other salvage options

In a vessel-depleted neck or after multiple flap failures, donor selection and recipient-vessel strategy become inseparable. A flap with a very long pedicle, a flow-through design, vein grafts, or recipient vessels outside the treated neck may be required. The contralateral neck, transverse cervical vessels, internal mammary system, thoracoacromial vessels, and cephalic vein are examples of salvage resources. These issues are developed in Volume IV; the donor-side lesson is that the backup flap should be chosen with its pedicle and recipient pathway already in mind.

Table 11. *Selected secondary donor sites and their rescue niches.*

Alternative flap	Tissue profile	Why it may be chosen	Main caution
Ulnar forearm	Thin fasciocutaneous.	Radial forearm unavailable; medial scar.	Hand perfusion and ulnar nerve.
Lateral arm	Thin-to-moderate fasciocutaneous.	Avoid major hand artery sacrifice; primary closure.	Shorter pedicle, smaller paddle, radial nerve.
PAP	Posterior-thigh skin and fat.	ALT unavailable or donor preference.	Positioning and perforator variability.
Omentum	Vascularized fat sheet.	Infected, irradiated, irregular cavity.	Abdominal surgery and contour variability.
Gracilis	Small muscle +/- skin.	Focused coverage or dynamic reconstruction.	Limited volume and skin reliability.
MFC	Small vascularized bone.	Nonunion or focal bony salvage.	Insufficient for long structural defects.

RESIDENT HABIT

A backup donor is not “whatever is left.” It must provide the same essential tissue functions and have a pedicle that can reach the actual recipient-vessel plan.

CHAPTER 10

Choosing Among the Workhorses

A practical comparison by tissue quality, geometry, patient, and donor cost

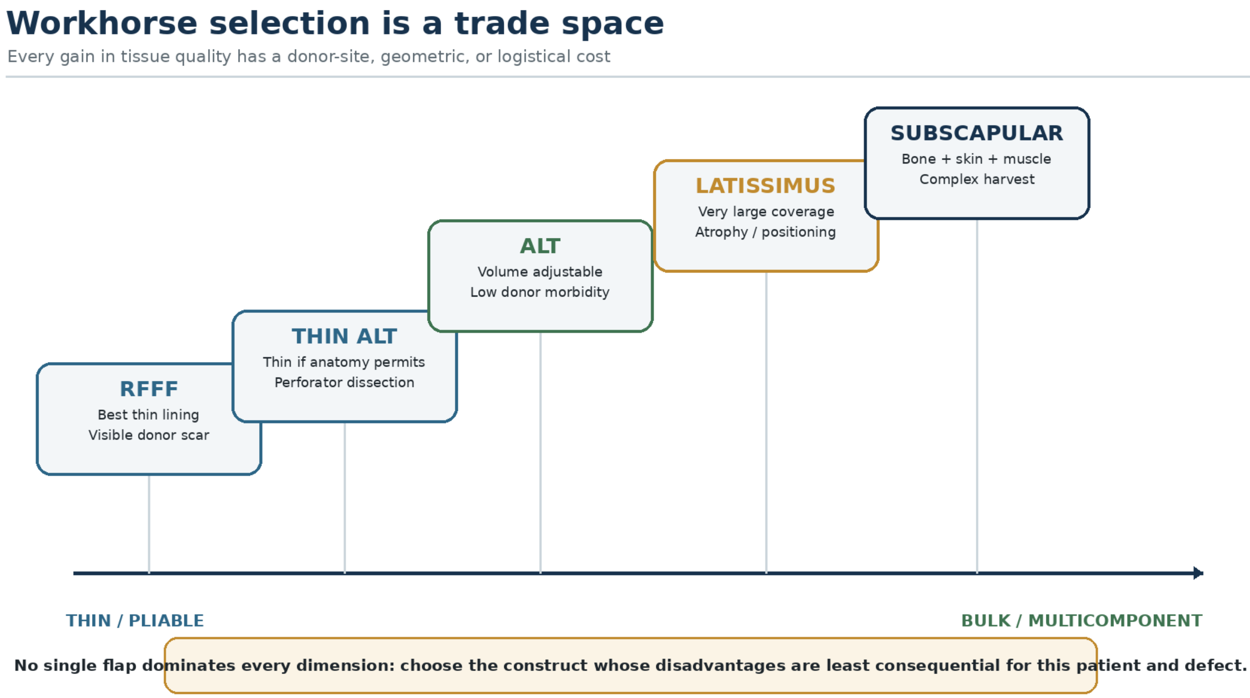


Figure 16. Soft-tissue flap selection exists along a continuum. Tissue thickness, component flexibility, harvest complexity, and donor morbidity move together rather than independently. Original synthesis diagram created for this guide.

Thin lining: radial forearm versus thin ALT

The radial forearm remains the most predictable source of thin, supple tissue. A thin ALT can approximate that profile in favorable anatomy while avoiding a grafted forearm, but the result depends on patient thickness and perforator course. When the defect is narrow, mobile, and intolerant of bulk, reliability of thinness may outweigh donor appearance. When a larger surface or additional volume is required, ALT usually offers more flexibility.

Large soft tissue: ALT versus latissimus versus abdominal tissue

ALT is the default large soft-tissue flap because it is supine, adjustable, and usually low morbidity. Latissimus becomes attractive when the defect is enormous, irregular, contaminated, or requires muscle to cover vital structures. Abdominal tissue offers substantial fat and a concealed donor site but adds abdominal-wall considerations and may be excessively thick. The reconstructive question is whether durable fat volume, conforming muscle, or a skin surface is the dominant need.

Vascularized bone: fibula versus scapula versus DCIA

Fibula wins on length, osteotomy freedom, pedicle, and a familiar two-team workflow. Scapula wins on independent soft-tissue components and can be preferable when lower-extremity vessels are poor or the defect is truly three-dimensional. DCIA wins on bone height, curvature, and corticocancellous implant stock but has a shorter pedicle and abdominal-wall cost. The “best bone flap” changes with the location and length of the defect, the soft-tissue requirement, and the patient’s donor anatomy.

Table 12. *Defect-to-donor heuristic. This table is a starting point, not a substitute for patient-specific planning.*

Clinical problem	Usually favored	Why	Important alternative
Thin partial-tongue or floor-of-mouth lining	RFFF	Predictably thin, pliable, long pedicle.	Thin ALT when anatomy and thickness permit.
Subtotal/total glossectomy	ALT	Adjustable bulk and large surface; possible muscle.	Rectus/DIEP or latissimus for exceptional volume.
Long anterior or lateral segmental mandible	Fibula	Length, osteotomies, pedicle, dental potential.	Scapula if soft-tissue complexity or leg disease dominates.
Short posterior mandible / angle with complex soft tissue	Scapular tip system	Shape and independent chimeric components.	Fibula or DCIA.
Lateral mandible with need for vertical bone height	DCIA	Curved, tall corticocancellous bone.	Fibula with vertical/double-barrel strategy.
Through-and-through cheek without bone	ALT with two paddles or folded design	Large skin territory and independent components.	RFFF for thinner small defects; double flaps for extreme geometry.
Circumferential pharyngoesophagus	Jejunum or tubed ALT	Native tube versus skin tube with soft-tissue coverage.	Tubed RFFF.
Large irradiated skull-base cavity	Latissimus, ALT with muscle, or subscapular construct	Robust vascularized bulk and dead-space fill.	Omentum or rectus/DIEP.
Vessel-depleted neck	Long-pedicle flap chosen with recipient strategy	Donor and recipient plan must be integrated.	Contralateral or extracervical recipient vessels, vein graft, flow-through design.

Patient factors that overturn the default

The usual workhorse should be abandoned when its donor cost is uniquely dangerous for the patient. A patient with severe peripheral arterial disease may be a poor fibula candidate. A wheelchair-dependent patient who transfers with the arms may value latissimus and forearm function differently. A violinist, surgeon, or manual laborer may prioritize the forearm donor site. A patient with prior laparotomy and hernia may be a poor DCIA or jejunal candidate. A very thin patient may not have enough ALT volume; a patient with marked thigh adiposity may have too much.

Patient preference is part of flap selection, but informed preference requires concrete discussion. “Thigh scar versus forearm scar” is incomplete. The discussion should include skin grafting, expected sensory change, possible weakness, rehabilitation, clothing visibility, and the chance that the donor plan changes intraoperatively because the anatomy is unfavorable.

The backup plan

A credible backup reproduces the essential functions of the primary construct. If the planned fibula is abandoned because of vascular anatomy, a scapular-system flap may replace both bone and soft tissue; a DCIA may replace bone but alter pedicle and positioning; a reconstruction plate with soft tissue may be an oncologically acceptable temporizing solution in a frail patient. If ALT perforators are absent, the contralateral thigh, radial forearm, PAP, or subscapular system may be considered. The team should know the sequence before the problem occurs.

MASTER RULE

Choose the flap whose unavoidable disadvantages are least harmful in this defect and this patient. “Workhorse” describes frequency and familiarity, not universal superiority.

CHAPTER 11

Clinical Cases and Boards Review

Applying donor anatomy to realistic reconstructive choices

Case 1: Thin mobile tongue reconstruction

CLINICAL VIGNETTE

A 48-year-old right-handed violinist requires a right partial glossectomy and floor-of-mouth resection. The expected defect is broad but shallow. The patient has thin thighs, normal forearm circulation, and is highly concerned about forearm appearance.

The defect needs pliable lining with minimal bulk. Radial forearm is mechanically ideal, but a thin ALT may achieve the same functional goal while avoiding the visible forearm donor site. Thigh thickness and perforator anatomy should be assessed rather than assuming ALT will be thin enough.

DEFENSIBLE RECONSTRUCTIVE PLAN

Primary plan: thin ALT if a suitable perforator and safe thinning plane are present. Backup: nondominant radial forearm after documented collateral hand perfusion.

COMMON ERROR

Selecting a bulky standard ALT solely to avoid a forearm scar can impair residual tongue mobility and sulcus depth.

Case 2: Long anterior mandibular defect

CLINICAL VIGNETTE

A 59-year-old with oral cavity cancer will undergo mandibulectomy from one body across the symphysis to the contralateral body, with moderate floor-of-mouth mucosal loss. Lower-extremity CTA shows normal three-vessel runoff.

The dominant requirement is long vascularized bone that tolerates several osteotomies and supports future dental rehabilitation. The anterior arch magnifies the need for accurate projection and occlusal planning.

DEFENSIBLE RECONSTRUCTIVE PLAN

Fibula osteocutaneous flap with virtual planning is the usual first choice. Skin-paddle perforators must be positioned to reach the floor of mouth without pedicle twist.

COMMON ERROR

Choosing DCIA for its height without accounting for the long bilateral defect and short pedicle may create unnecessary geometric constraints.

Case 3: Peroneal-dominant circulation

CLINICAL VIGNETTE

A patient planned for fibula reconstruction has palpable foot pulses, but CTA shows a dominant peroneal artery with hypoplastic anterior and posterior tibial arteries distally.

Palpable pulses do not make peroneal sacrifice safe. The imaging defines a limb in which the proposed pedicle is critical to foot perfusion.

DEFENSIBLE RECONSTRUCTIVE PLAN

Abandon fibula. Consider scapular-system or DCIA bone according to defect length and soft-tissue requirements.

COMMON ERROR

Proceeding because the bedside pulse exam is “normal.”

Case 4: Complex maxillectomy

CLINICAL VIGNETTE

A total maxillectomy includes palate, alveolus, anterior wall, and orbital floor, with a large cavity but no external skin loss. The legs have severe vascular disease.

The defect requires bone in multiple planes and independently mobile soft tissue for palatal separation and dead-space obliteration. Lower-extremity disease disfavors fibula.

DEFENSIBLE RECONSTRUCTIVE PLAN

A scapular-tip chimeric construct with latissimus or teres/other subscapular component is attractive. DCIA may provide bone height but offers less independent soft-tissue freedom.

COMMON ERROR

Selecting a skin-bone flap whose paddle is tethered to the bone and cannot reach the palate after orbital support is restored.

Case 5: Circumferential pharyngoesophageal defect

CLINICAL VIGNETTE

A 66-year-old undergoes total laryngopharyngectomy. The neck skin is intact, recipient vessels are favorable, and there is little dead space. The patient has no prior abdominal surgery.

The central problem is a durable conduit. Both jejunum and tubed fasciocutaneous flaps are reasonable; institutional expertise and functional priorities matter.

DEFENSIBLE RECONSTRUCTIVE PLAN

Free jejunum is defensible in an experienced program. Tubed ALT is also appropriate, particularly if additional neck soft tissue or a monitor paddle is valued.

COMMON ERROR

Calling one option categorically superior without considering abdominal risk, monitoring, speech strategy, and local outcomes.

Case 6: Salvage skull-base defect

CLINICAL VIGNETTE

A previously irradiated patient has a recurrent lateral skull-base tumor requiring temporal bone resection, dural repair, vessel coverage, and a large irregular dead space.

The reconstruction needs vascularized bulk and conforming coverage more than a thin skin surface. Long-term muscle atrophy should be anticipated.

DEFENSIBLE RECONSTRUCTIVE PLAN

Latissimus dorsi, ALT with muscle, or a chimeric subscapular construct; choose based on volume, positioning, skin need, and recipient-vessel plan.

COMMON ERROR

Using a thin fasciocutaneous flap that seals the surface but leaves a poorly vascularized cavity around dura and vessels.

Rapid boards questions

Table 13. *High-yield boards review.*

Question	Answer
Which flap is based on the radial artery and is classically thin and pliable?	Radial forearm free flap.
What bedside principle must be satisfied before radial artery sacrifice?	Adequate collateral hand perfusion through the ulnar system and palmar arch.
What is the most common course of ALT perforators?	Musculocutaneous through vastus lateralis.
What source vessel supplies the ALT?	Most commonly the descending branch of the lateral circumflex femoral artery.
Which osseous flap provides the longest bone segment and tolerates multiple osteotomies?	Fibula osteocutaneous flap.
What vascular variant is a classic contraindication to fibula harvest?	Peronea arteria magna or otherwise dominant peroneal supply to the foot.

Question	Answer
Which system provides scapular skin, latissimus, serratus, and scapular-tip bone?	The subscapular system.
Which vessel supplies scapular-tip bone?	The angular branch of the thoracodorsal system.
Which osseous flap has natural mandibular curvature and substantial vertical bone but a short pedicle?	DCIA iliac-crest flap.
What is the classic donor complication of OCRFFF?	Radius fracture; prophylactic plating reduces the risk.
Which visceral flap is used for circumferential pharyngoesophageal reconstruction?	Free jejunum.
How should jejunum be oriented?	Isoperistaltically from pharynx toward esophagus.
Which flap is generally the most adjustable soft-tissue workhorse?	ALT, because thickness and components can be tailored.
Which flap is usually most predictable for thin oral lining?	Radial forearm.
Which donor system offers the greatest chimeric component independence?	Subscapular system.

Last-minute pearls

- **RFFF:** thin, pliable, long pedicle; radial artery; grafted forearm and visible donor morbidity.
- **ALT:** descending LCFA; usually musculocutaneous perforators; adjustable thickness; fascia and muscle options.
- **Fibula:** peroneal system; long bicortical bone; multiple osteotomies; assess runoff and peroneal dominance.
- **Subscapular system:** best chimeric menu; circumflex scapular skin/bone and thoracodorsal muscle/scapular-tip branches.
- **DCIA:** curved tall bone and implant stock; shorter pedicle; abdominal wall and hernia concerns.
- **OCRFFF:** thin skin plus limited radius; prophylactic plate because fracture is the classic complication.
- **Latissimus:** large muscle and skin; excellent coverage; denervation atrophy and shoulder tradeoff.
- **Jejunum:** native lubricated tube; isoperistaltic; abdominal donor and buried monitoring.
- **Chimeric:** independent components on separate branches sharing a source pedicle.
- **Backup plan:** must reproduce essential tissue functions and fit the recipient-vessel strategy.

CHAPTER A

Appendix A: Rapid Reference Tables

Anatomy, tissue components, donor-site costs, and selection cues

Table 14. *Workhorse free-flap anatomy and selection matrix.*

Flap	Pedicle	Components	Pedicle length	Best niche	Donor/technical cost
Radial forearm	Radial artery; venae comitantes +/- cephalic vein	Thin skin, fascia, tendon, sensory nerve, limited radius	Long	Thin lining, folded/tubed constructs	Grafted visible forearm; artery sacrifice; sensory/tendon issues
ALT	Descending LCFA; venae comitantes	Skin/fat, fascia lata, vastus lateralis, sensory nerve, multiple paddles	Long	Adjustable soft tissue, tongue, cheek, scalp, pharynx	Perforator variability; thickness; motor-nerve injury
Fibula	Peroneal artery and venae comitantes	Long bone, skin, FHL/soleus components	Long	Mandible/maxilla with long bone and dental goals	Vascular selection, wound, ankle/gait, toe symptoms
Scapular system	Circumflex scapular and/or thoracodorsal branches	Skin, muscle, fascia, scapular border/tip, rib	Variable	Complex 3-D composite defects, leg disease	Positioning, harvest complexity, shoulder morbidity
DCIA	Deep circumflex iliac artery/vein	Iliac bone, internal oblique, limited skin	Short-moderate	Tall curved bone, lateral mandible, implants	Pain, gait, bulge/hernia, short pedicle
Latissimus	Thoracodorsal artery/vein	Large muscle +/- skin	Long	Massive coverage and dead space	Atrophy, shoulder function, positioning
Jejunum	Mesenteric artery and vein	Intestinal tube	Moderate	Circumferential pharyngoesophagus	Laparotomy, buried monitoring, ischemia sensitivity

Expected donor deficits

Table 15. *Donor-site counseling in anatomically coherent terms.*

Donor	Expected counseling points
RFFF	Forearm contour/scar, sensory change, stiffness or grip/endurance change; rare hand ischemia if selection is wrong.
ALT	Lateral thigh numbness, seroma, wound issues; weakness if substantial vastus or motor nerve is sacrificed.
Fibula	Ankle stiffness/weakness, gait change, sensory symptoms, toe weakness or contracture, grafted leg wound.
Subscapular	Shoulder pain/weakness or reduced motion; latissimus loss may matter for transfers or overhead activity.
DCIA	Hip/groin pain, numbness, temporary gait change, contour change, abdominal-wall bulge or hernia.
Rectus/DIEP	Abdominal weakness, bulge/hernia, seroma; less muscle morbidity with perforator harvest.
Jejunum	Ileus, obstruction, leak, wound complication, hernia, abdominal pain.

When to abandon a planned donor

Table 16. *Common reasons to abandon or modify the primary donor plan.*

Planned donor	Stop or change course when…
RFFF	Inadequate collateral hand perfusion; major vessel injury or severe scar; unacceptable donor preference after counseling.
ALT	No usable perforator or pedicle; unsafe thickness for the defect without reliable thinning; major prior donor disruption.
Fibula	Peroneal-dominant circulation; inadequate runoff; severe vascular disease; unstable or functionally critical limb; compromised perforators.
Subscapular	Source-vessel injury from prior axillary surgery/radiation; unusable positioning; inadequate bone or branch anatomy.
DCIA	Major abdominal-wall disease or prior disruption; pedicle cannot reach; bone geometry inadequate.
Jejunum	Unsafe abdomen, unsuitable mesenteric arcade, bowel disease, or patient physiology incompatible with abdominal harvest.

CHAPTER B

Appendix B: Resident Checklists

Preoperative preparation and what to observe during harvest

Preoperative donor checklist

- Confirm the exact donor, side, and backup donor in the operative plan.
- Review scars, prior surgery, trauma, vascular access, radiation, and donor-specific functional demands.
- Examine distal perfusion and document the relevant pulses or collateral assessment.
- Personally review lower-extremity vascular imaging before fibula harvest; do not rely only on the report impression.
- Know whether the planned skin paddle will close primarily or require grafting.
- Know which tissue components are required: skin, fat, fascia, muscle, bone, tendon, nerve, or bowel.
- Know the expected recipient-vessel side and whether pedicle length is likely to be limiting.
- Protect the selected donor from unnecessary IVs, arterial lines, compression, or skin injury.
- Confirm positioning, tourniquet plan, graft donor, splint/boot, and postoperative mobility restrictions.
- Understand the trigger for switching to the backup donor.

What the resident should identify in the operating room

Table 17. *Key structures for resident orientation during harvest.*

Flap	Structures to identify and protect
RFFF	Radial artery and venae comitantes; cephalic vein; superficial radial nerve; lateral antebrachial cutaneous nerve; flexor tendon paratenon.
ALT	Rectus femoris/vastus lateralis interval; descending LCFA; perforator course; motor nerve to vastus lateralis; lateral femoral cutaneous nerve; fascia lata.
Fibula	Common peroneal nerve proximally; peroneal vessels; selected skin perforators; FHL cuff; proximal/distal stabilizing segments; foot perfusion.
Subscapular	Subscapular artery; circumflex scapular and thoracodorsal branches; triangular space; thoracodorsal nerve; angular and serratus branches.
DCIA	External iliac origin of DCIA; ascending branch; internal oblique; lateral femoral cutaneous nerve; abdominal-wall fascial layers.
Jejunum	Mesenteric arcade, proximal/distal orientation, isoperistaltic direction, bowel anastomosis, mesenteric twist and tension.

Back-table questions

9. Which artery and vein are the intended anastomotic ends?
10. Which skin perforator or branch supplies each tissue component?
11. How will the pedicle exit the final construct?
12. What degree of rotation can the skin paddle tolerate without twisting the perforator?
13. Which tissue can be safely trimmed, thinned, de-epithelialized, or divided?
14. Where must periosteum, fascia, or mesentery remain attached to preserve perfusion?
15. How will the flap be monitored after inset?
16. What donor-specific complication must be checked before leaving the operating room?

EDUCATIONAL SAFETY NOTE

This checklist supports learning and communication. Harvest and intraoperative decisions remain attending-directed and must follow institutional protocols.

CHAPTER C

Appendix C: Glossary

Terms used in donor-site anatomy and flap design

Table 18. *Glossary of donor-site and flap-design terms.*

Term	Definition
Axial flap	A flap supplied by a named vessel running along its axis with predictable cutaneous branches.
Chimeric flap	Two or more independently mobile tissue components supplied by separate branches that converge on a common source pedicle.
Composite flap	A flap containing more than one tissue type, such as skin and bone.
Dominant vessel	An artery whose sacrifice would critically reduce distal perfusion because alternative arterial supply is absent or inadequate.
Musculocutaneous perforator	A vessel that traverses muscle before reaching the skin.
Osteocutaneous flap	Vascularized bone and skin transferred on a shared source pedicle.
Paratenon	Vascular connective tissue surrounding a tendon; preservation supports skin-graft healing.
Pedicle	The donor artery, vein or veins, and associated tissue that maintain flap perfusion until microvascular anastomosis.
Perforator	A vessel that passes through or between deeper structures to supply skin and subcutaneous tissue.
Peronea arteria magna	An anatomic pattern in which the peroneal artery is the dominant arterial supply to the foot.
Septocutaneous perforator	A perforator that reaches the skin through an intermuscular septum rather than traversing muscle.
Skin paddle	The cutaneous component of a flap, used for lining, external cover, or postoperative monitoring.
Suprafascial harvest	Elevation superficial to deep fascia, often used to reduce flap thickness or donor morbidity.
Venae comitantes	Paired veins accompanying an artery in the deep vascular system.
Visceral flap	Transfer of a vascularized organ segment, such as jejunum, for reconstruction.
Flow-through flap	A flap in which the pedicle also reconstructs continuity of a recipient artery by using proximal and distal anastomoses.

CHAPTER D

Appendix D: References and Figure Credits

Core reviews, anatomy papers, outcome studies, and attribution for web-sourced figures

This guide is an educational synthesis. Pedicle measurements, harvest details, imaging protocols, antithrombotic practice, and postoperative restrictions vary among surgeons and institutions. Patient-specific decisions should be made by the treating reconstructive team.

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Table 19. *Figure attribution and adaptation notes.*

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