OPEN ACCESS ATLAS OF OTOLARYNGOLOGY, HEAD & NECK OPERATIVE SURGERY

ANTEROLATERAL THIGH (ALT) FREE FLAP FOR HEAD AND NECK RECONSTRUCTION

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The Anterolateral Thigh (ALT) flap has gained increased popularity for head and neck reconstruction, mainly due to its minimal donor site morbidity.

Although it is a fasciocutaneous flap, it can be harvested with a cuff of *vastus lateralis* muscle. It is based on perforators of the descending branch of the lateral circumflex femoral artery and can provide large areas of vascularised skin for reconstruction. It can be used for any soft tissue reconstruction including facial skin, oral cavity *e.g.* partial or total glossectomy, and as semi-tubed or tubed flaps for pharyngeal defects.

Benefits of the ALT flap include

- Minimal functional and cosmetic donor site morbidity
- The scar may be hidden under clothing
- Up to 10x25cm of skin can be harvested and still achieve primary closure of the donor site
- Even larger areas of skin can be harvested with split thickness graft coverage of the donor site
- Long vascular pedicle
- 2-5mm diameter artery
- Donor site far from head enabling two-team approach
- Once the surgeon is familiar with the anatomy and its variations, it is easy and quick to harvest
- Can be harvested as a sensate flap using the lateral femoral cutaneous nerve
- Access to branches of femoral nerve to harvest nerve grafts *e.g.* for facial nerve reanimation
- Most of the flap can be raised without committing to a final design; this permits one to start harvesting the flap before knowing the final dimensions of the defect

Caveats include

- A bulky flap in patients with large thighs may preclude its use
- Significant perforator and vascular variations make it a somewhat more challenging flap for inexperienced microsurgeons
- The scar is always long, often stretched and unsightly; if a skin graft is required for donor site closure, the cosmetic result may be poor

Surgical anatomy

A sound knowledge of the anatomy of the anterolateral thigh is essential before attempting to harvest an ALT flap.

Fasciae and muscles *(Figures 1, 2)*

The *fascia lata* is the deep fascia of the thigh, and completely encircles the muscles of the thigh. Its thickness varies; laterally it becomes thicker as it forms the iliotibial tract, a structure that runs to the tibia and serves as a muscle attachment. Superolaterally the *fascia lata* splits and encloses the *tensor fascia lata* muscle.

The thigh is divided into ***three separate compartments*** by septa. Each compartment has its own blood and nerve supply. The compartments are:

1. Anterior fascial compartment containing the extensors
2. Posterior fascial compartment containing the flexors
3. Medial fascial compartment containing the adductors

As only the anterior fascial compartment is encountered when harvesting the ALT flap, the other compartments are not further described in this chapter.

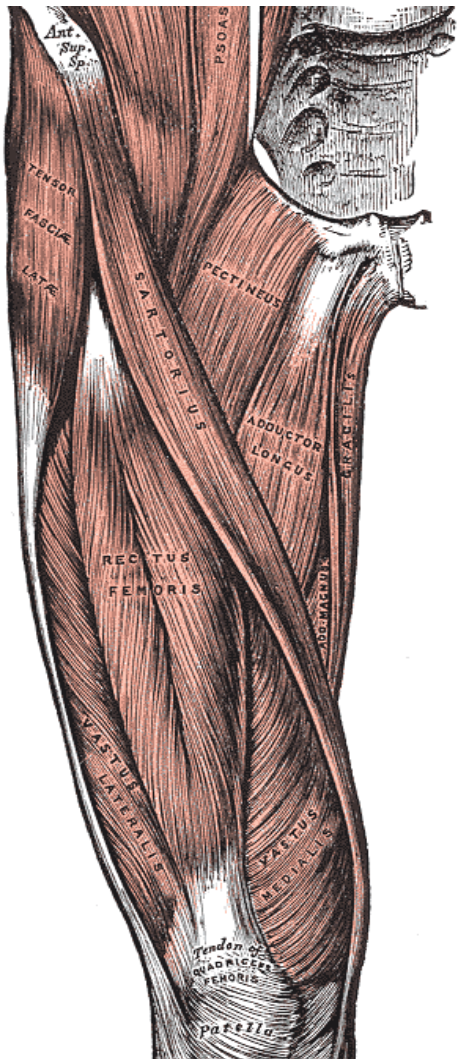


Figure 1: Muscles of thigh

Muscles in the anterior compartment of the thigh include the *pectinus*, *sartorius*, and the four muscles of the quadriceps *i.e. rectus femoris*, *vastus medialis*, *vastus intermedius* and *vastus lateralis*. ***All the quadriceps muscles***, ***except the vastus medialis***, ***are encountered*** during ALT flap harvest.

The *rectus femoris* occupies the middle of the thigh. It originates on the ilium and attaches to the tibia via the patella. The other three vastus muscles originate from the body of the femur and join the *rectus femoris* by a strong tendon at the patella. The *vastus intermedius* lies deep to the *rectus femoris* and is not seen until this muscle is reflected. The *sartorius* is sometimes encountered superiorly when harvesting the flap, especially when opening the compartment between *rectus femoris* and *vastus lateralis* to gain access to the proximal vascular pedicle *(Figure 1)*. It is a thin, superficial muscle that arises by tendinous fibers from the anterior superior iliac spine and runs obliquely across the upper and anterior part of the thigh in an inferomedial direction. It joins the tendons of *gracilis* and *semitendinosus* on the medial aspect of the knee as the *pes anserinus* before it attaches to the medial aspect of the tibia.

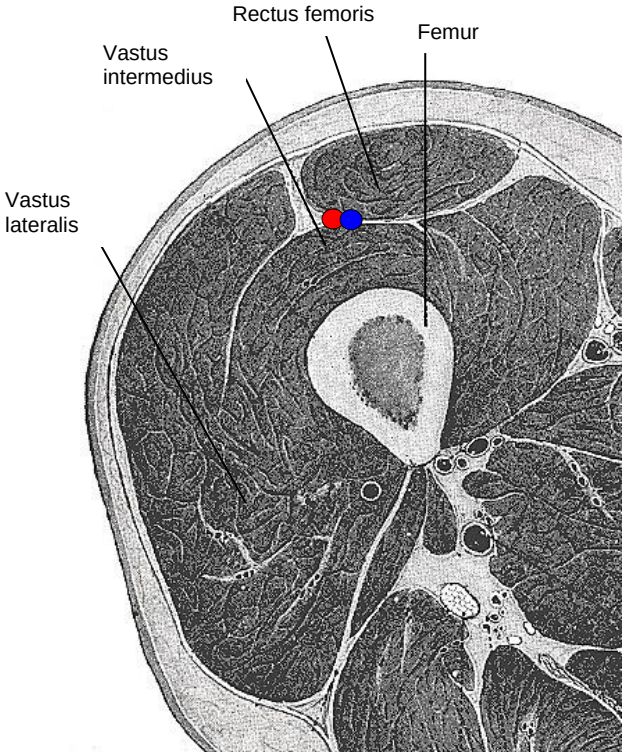


Figure 2: Cross-sectional anatomy of thigh indicating position of descending branch of lateral circumflex femoral artery and venae comitantes

Vascular anatomy *(Figures 2, 3)*

Where the external iliac artery passes under the inguinal ligament it becomes the common femoral artery. The common femoral artery gives off the *profunda femoris* artery

and continues as the superficial femoral artery.

The *lateral femoral circumflex artery* arises from the lateral side of the *profunda femoris*, passes horizontally between the divisions of the femoral nerve, and behind the *sartorius* and *rectus femoris*, and divides into ascending, transverse, and descending branches. The lateral femoral circumflex artery may occasionally arise directly from the femoral artery.

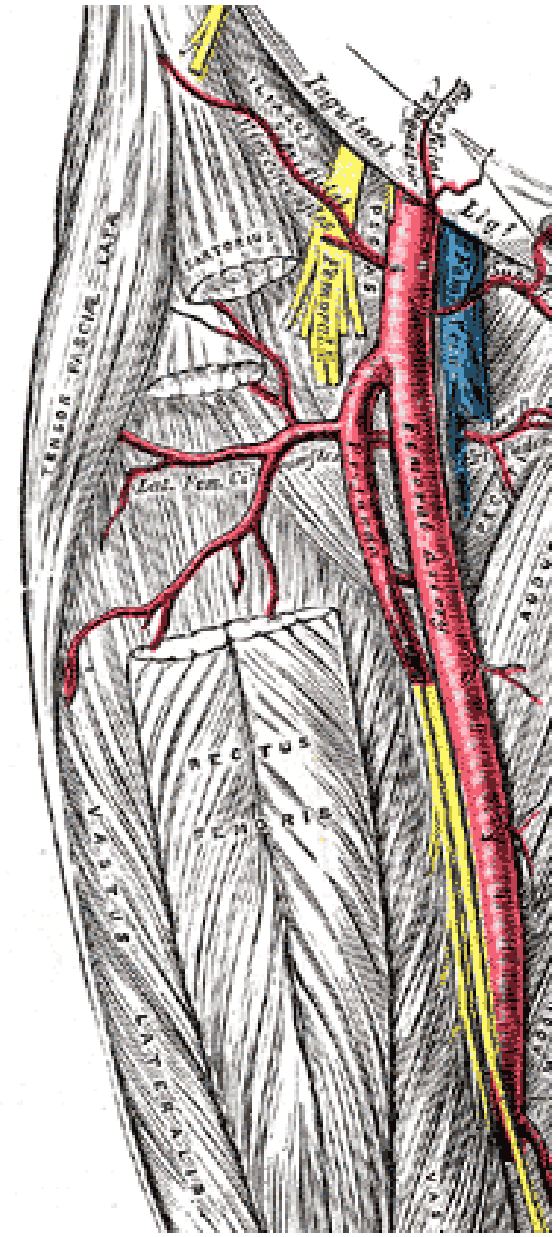


Figure 3: Lateral femoral circumflex artery branches from profunda femoris

The ascending branch of the lateral circumflex femoral artery passes superiorly, underneath the *tensor fasciae lata* muscle and eventually anastomoses with branches of the deep circumflex iliac artery.

The *descending branch* of the lateral circumflex femoral artery runs inferiorly, under the *rectus femoris*, and along the anterior aspect of *vastus lateralis (Figure 3)*. The continuation of this artery anastomoses with the superior lateral genicular artery.

A distinct *oblique branch* of the lateral femoral circumflex artery is found in about 35% of cases. It lies proximal, between the lateral and descending branches of the lateral femoral circumflex artery and most commonly arises from one of the above two branches. It enters the *vastus lateralis* in its proximal third.[2]

The *transverse branch* of the lateral circumflex femoral artery passes laterally over the *vastus intermedius* and pierces the *vastus lateralis (Figure 3)*.

Perforator concept and variability

Most of the body's skin is supplied by perforators from larger vessels that run deep to muscles. These perforators branch out to supply the subdermal plexus. Perforators can be septocutaneous (S) or musculocutaneous (M); with ALT flaps, approximately 85% are musculocutaneous and 15% are septocutaneous.

When raising an ALT flap, perforators can conveniently be named Perforators "A", "B" and "C" *(Figure 4)*.

- ***Perforator B*** is the most reliable and is present in about 90% of legs. It enters the skin about midway between the anterior superior iliac spine and the patella
- ***Perforator A*** is located about 5cm proximal to "B" and is present in about 50% of legs

- ***Perforator C*** is located 5cm distal to "B" and is present in about 60% of legs

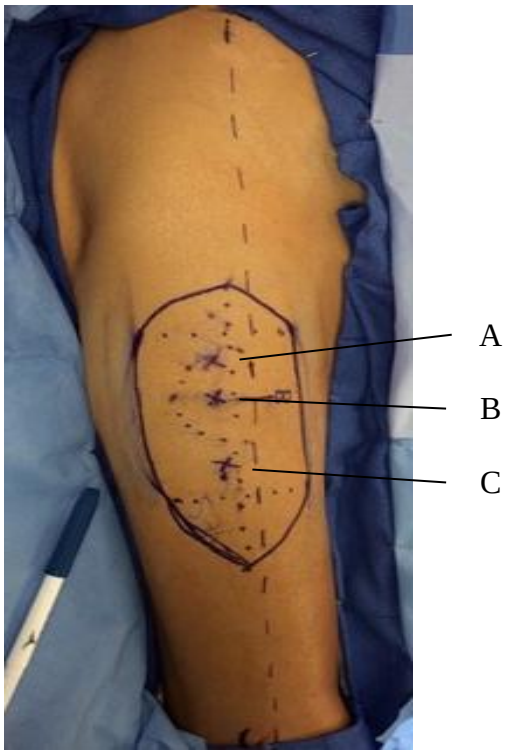


Figure 4: Perforators of (R) thigh

Twenty five percent of legs have only one perforator; 50% have 2 perforators; and 24% have 3 perforators. About 1% have no perforators at all; in such cases a perforator is found on the contralateral side in about 2/3 of cases.[1]

Innervation

Motor innervation (Figure 5)

The ***femoral nerve*** arises from the ventral rami of the 2nd to 4th lumbar nerves. After passing through the *psoas major* muscle and beneath the inguinal ligament, it enters the thigh and splits into anterior and posterior divisions. From the posterior division, a branch enters the *rectus femoris* on its inner surface. A large branch from the posterior division accompanies the descending branch of the lateral femoral circumflex artery to the lower part of *vastus lateralis*.

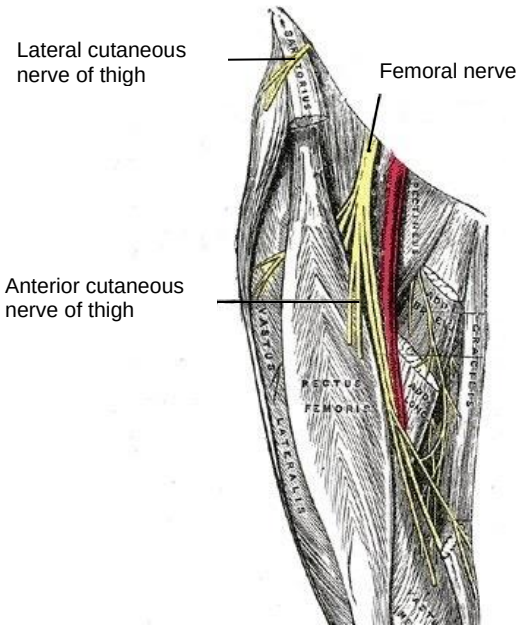


Figure 5: Lateral and anterior cutaneous nerves of thigh

Sensory innervation (Figure 5)

The ALT flap can be harvested as a sensate flap by including the ***lateral cutaneous nerve*** of the thigh. This nerve arises from the lumbar plexus. As it enters the thigh, it passes under the inguinal ligament, through the *lacuna musculorum*. An ***anterior cutaneous branch*** becomes superficial about 10cm below the inguinal ligament where branches provide sensation to the anterior and lateral thigh.

Chimeric ALT flaps

Chimeric flaps consist of multiple independent flaps that each have an independent vascular supply, with all pedicles linked to a common vessel of origin. Once familiar with the anatomy of the ALT flap and its variations, different chimeric flaps can be fashioned. When there are robust perforators, separate skin paddles can be harvested if two separate defects exist, such as for an internal and external lining. The flap can also be harvested with a separate cuff of muscle based on the distal pedicle; or

alternatively based on the transverse branch of the lateral circumflex femoral artery.

Informed consent

Discussion should include the risk of seroma or haematoma formation and development of an unsightly scar. Patients must also be counselled about the general risks of free flap surgery, such as flap failure and needing to reexplore a failing flap.

Prepping and draping

- Internally rotate the leg to enable ***easier*** harvesting, by elevating the ipsilateral hip off the bed with a folded sheet, a vacoliter, or 3-litre bag placed under the buttock
- Prep the anterior, medial and lateral thigh
- Drape in a sterile fashion to expose the thigh from the inguinal ligament to just below the knee
- Expose enough skin posteriorly to not limit surgical access

Flap design

Identify where perforators enter the skin

- Draw a straight line from the anterior iliac spine to the lateral border of the patella *(Figure 6)*
- Make a mark 2cms lateral to the midpoint of this line; it is usually possible to locate a dominant perforator within a 3cm radius around this point *(Figure 7)*
- Although Doppler has poor specificity, it is useful early in one's career to map the perforators. It provides one with a good sense where the perforators are, and influences where the flap is placed *(Figure 8)*

Figure 6: Straight line from anterior iliac spine to lateral patella of (R) leg

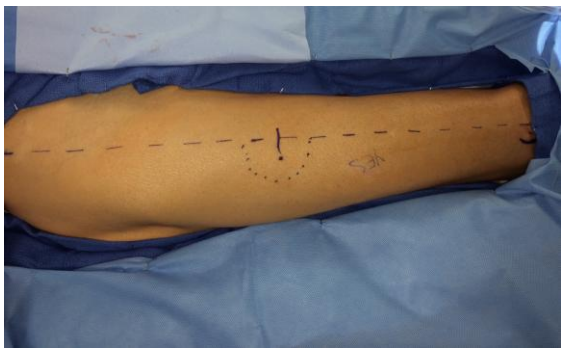


Figure 7: Mark 2cm lateral to midpoint of this line and draw a 3cm radius

Figure 8: Perforators mapped with Doppler

Tentative design of the flap

- It is based on the location of the perforators *(Figure 9)*
- The design can later be modified depending on where the perforators are found to be located at surgery
- Be careful to not to blindly commit the design to the Doppler perforator location

Figure 9: Tentative flap design based on location of perforators

Surgical steps *(Figure 10)*

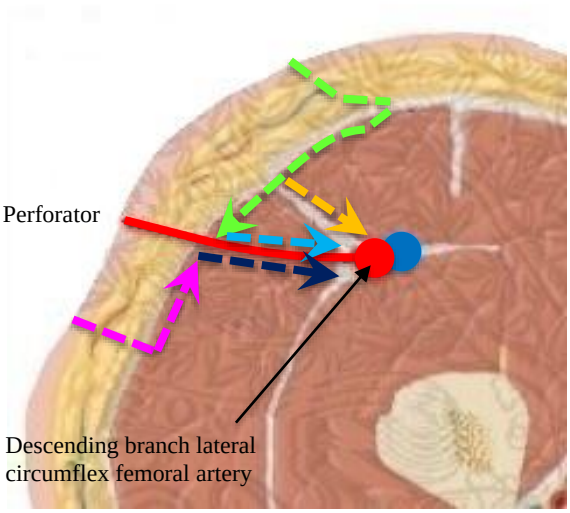


Figure 10: Sequence of surgical steps for pedicle skeletonisation or muscle cuff perforator dissection

1. *Medial Elevation*
2. *Septal dissection between vastus intermedius and rectus femoris*
3. *Deroofing*
4. *Perforator skeletonisation*
5. *Lateral flap elevation*

Flap Harvest

Commence with a medial incision *(Figures 10, 11)*

- The position of the medial incision is critical
- ***If placed too medially***, the flap width, (to included perforators which may be situated more laterally than expected) may end up being too wide to achieve primary skin closure

Figure 11: Commence with a medial incision

- More often, however, the incision is ***placed a little too lateral*** with the perforators piercing the deep fascia alarmingly close to the medial edge of the flap
- ***Therefore, bevel the dissection medially*** to ensure that perforators are not injured if the flap was placed too laterally *(Figure 10)*
- Extend the subcutaneous dissection medially while checking for perforators or suprafascial fascial vessels running laterally, before incising the deep fascia on the surface of the *rectus femoris*
- Extend the incision longitudinally, ensuring that the correct compartment has been entered (*Figure 12*)

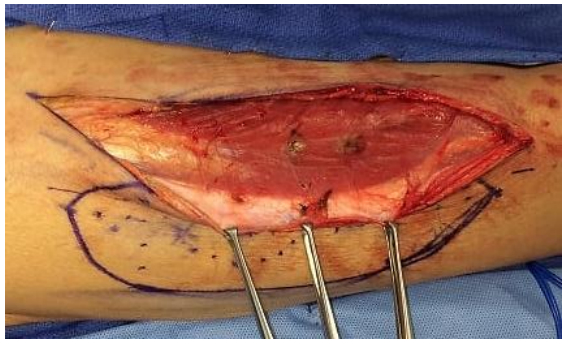
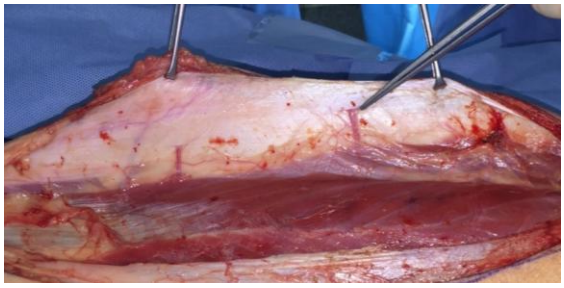


Figure 12: Medial incision through skin and fascia lata lifting fascia off the rectus femoris; ensure that the correct compart-

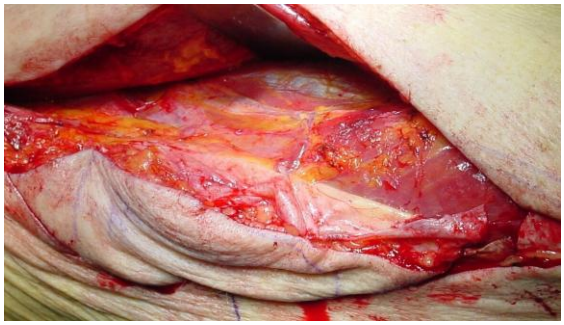
ment has been entered; note fishtail configuration of rectus femoris

- The *rectus femoris* has a typical fish tail pattern with the "arrows" pointing towards the groin *(Figure 12)*

Look for the perforators emerging from the thigh and entering the fascia and skin *(Figure 13)*



13a: Instrument points to a musculocutaneous perforator



13b: Septocutaneous perforator (Right leg)

- This surgical step needs to be performed with ***utmost care*** as it is easy to injure the perforators at this stage
- Always maintain an absolutely dry, ***bloodless field*** when doing perforator flap surgery to ensure excellent vision of the perforators
- Initial identification of the perforators may be best done by standing on the opposite side of the patient, while the assistant elevates the lateral fascia with skin hooks
- Retract the muscles medially with a raytec swab and incise the thin fascia over the *rectus femoris*
- Maintain this counter traction and skeletonise the muscle laterally with great care using a No. 15 blade, while looking for perforators
- If no septocutaneous perforators are found, divide the thin fascia over *vastus lateralis* and continue to skeletonise laterally over the latter muscle
- Always continue looking proximally and distally for more perforators
- Then, using scissor-spread dissection, check for more laterally placed perforators
- Do not divide secondary perforators until the major perforator has been dissected without being traumatised
- Large flaps require >2 perforators; it is worthwhile including more perforators even in small flaps if they are nearby
- Once one has located all the perforators and ensured that no further perforators exist, proceed to locate the pedicle

Locating the pedicle

- Incise the thin fascia surrounding the *rectus femoris*
- Slide a finger between the muscle and the fascia to open this plane *(Figure 14)*

Figure 14: Sliding a finger between rectus femoris and its fascia

- Retract the *rectus femoris* muscle medially
- Superiorly the *sartorius* is encountered and is retracted medially to enable easy

exposure of the pedicle later during the surgery
- The pedicle should now be visible as it runs deep to the *rectus femoris* on top of the *vastus intermedius*

Perforator dissection

- Perforator dissection should always be done with controlled tension, gently stretching the vessel. The assistant retracts nearby muscles with a skin hook or catspaw
- As the perforators are most often musculocutaneous, they are followed through the muscle until they meet the pedicle *(Figures 15, 16)*

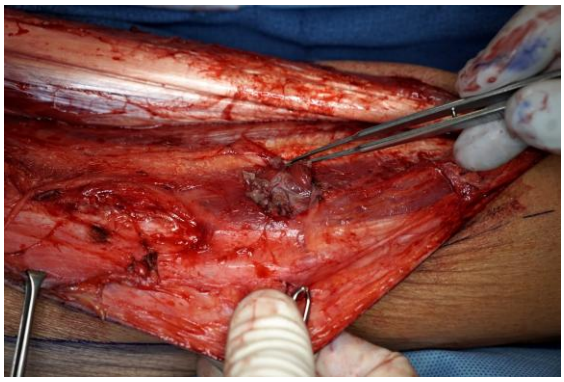


Figure 15: Dissecting through muscle leaving a small cuff of vastus lateralis on the perforator

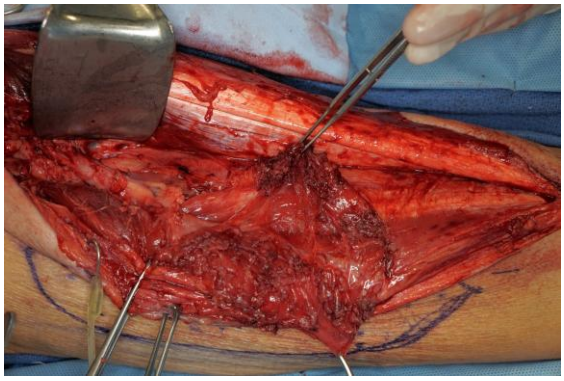


Figure 16: Perforator dissection

- Anterior/superficial to the perforators there are very few branches entering *vastus lateralis* and the muscle can be divided relatively bloodlessly
- Always stay on the surface of the vessels and avoid losing sight of its course and thus accidentally injuring the vessels
- Dissect with a *fine, blunt tipped scissors* using a spreading action, and under direct vision
- Cut the anterior muscle with scissors
- Compete this "de-roofing" procedure with all the perforators
- Skeletonise the perforators meticulously, working from distal to proximal
- Very small side and deep branches may be coagulated with bipolar coagulation, but always at a safe distance away from the perforator
- Use small Liga clips to divide larger branches
- ***Muscle cuff perforator dissection*** is an alternative method and is also done following deroofing. Instead of complete perforator dissection, a ***small cuff*** of muscle around the underside of the perforator is included or, alternatively, one can omit the perforator dissection completely and instead harvest a ***large cuff*** of muscle to ensure that the perforators are incorporated within the muscle. With both these procedures, one may encounter troublesome bleeding from side branches which, being surrounded by muscle, require more robust coagulation and thus, without having perfect visualisation of the perforator, can cause perforator injury.

Dissecting the vascular pedicle

- Follow the pedicle proximally until a decent caliber artery and vein are identified *(Figure 17)*
- Large branches to the undersurface of *rectus femoris* are encountered
- Significant variations in vascular anatomy are encountered especially of the vein. The two *venae comitantes* often

merge into a single vein before entering the deep femoral vein
- With gentle blunt dissection, separate the *fascia lata* from the *vastus lateralis* lateral to the perforators

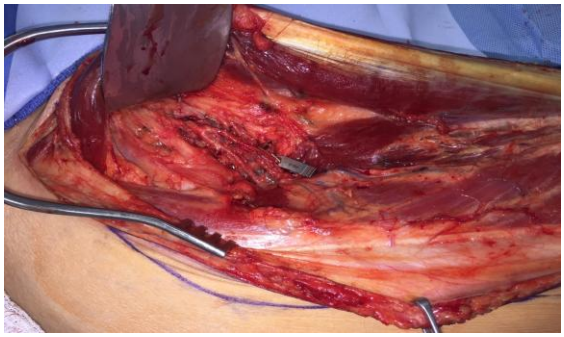


Figure 17: Pedicle exposed

Making the lateral skin incision

- Ensure that the flap design does not need to be readjusted before making the lateral skin incision
- Incise the skin and subcutaneous tissue down to *fascia lata (Figures 10, 18)*

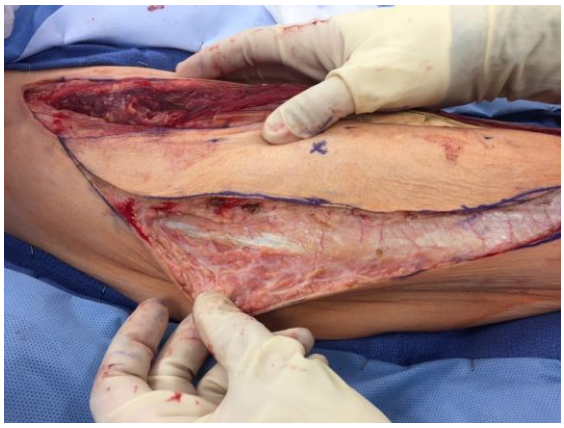


Figure 18: Incise skin, subcutaneous tissue down to fascia lata

- A cuff of *fascia lata* can be incorporated as needed
- Incise the fascia while protecting the perforators with a finger placed in the previously created tunnel lateral to the perforators *(Figure 19)*

Figure 19: With a finger protecting the perforators incise the fascia

- Superiorly the *fascia lata* splits, with the *tensor fascia lata* muscle located between these fascial layers *(Figure 20)*
- Depending of what the reconstructive needs are, a cuff of muscle can be harvested. Unless a muscle cuff is needed, ensure that you dissect on the inner aspect of this fascia

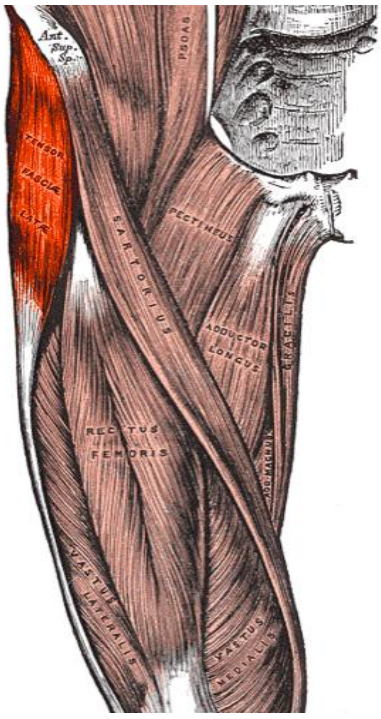


Figure 20: Tensor lata fascia and muscle

- While keeping the perforators in view, continue the back-dissection while protecting the pedicle *(Figure 10)*

- Use skin staples to secure the flap to the donor site to avoid inadvertent traction injury to the pedicle while preparing the vessels in the neck

Harvesting the flap

- Ligate the artery and vein with suture ligatures
- Harvest the flap *(Figure 21)*

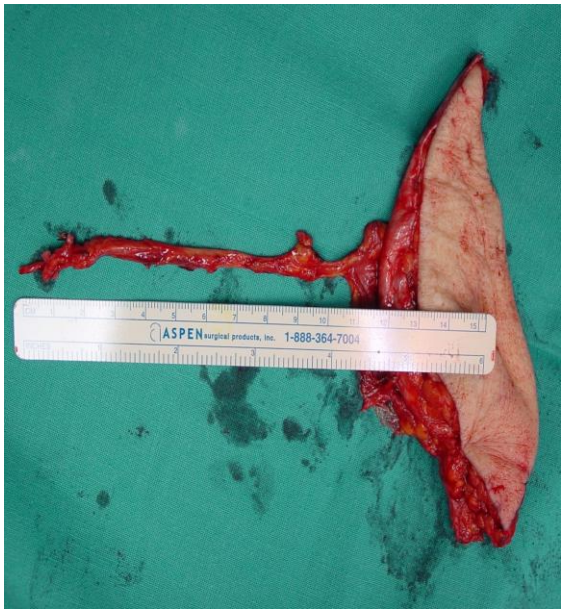


Figure 21: ALT flap

- Use utmost care when transferring the perforator pedicle to the donor vessel site to avoid rotation of the pedicle which may cause vascular compromise and flap loss
- The surgical technique of microvascular anastomosis is discussed in the chapter: *Principles and technique of microvas-cular anastomosis for free tissue trans-fer flaps in head and neck reconstruc--tive surgery*
- Following completion of the microvascular anastomosis, it may be prudent to anchor the pedicle to the surrounding tissues in the neck with 6/0 nylon to avoid rotation or kinking of the perforator and vascular pedicle

Closure of the thigh

- Achieve meticulous haemostasis
- Insert a closed suction drain
- Close the leg in layers using absorbable sutures for deep dermis and staples or subcuticular sutures for skin; subcuticular absorbable skin sutures yield a better cosmetic result *(Figure 22)*

Figure 22: Closure with suction drain

- Suprafascial skin flaps may be raised to achieve a tension free closure
- Occasionally the donor defect must be skin grafted. Skin graft take on muscle is very reliable but does compromise cosmesis

Postoperative care

- Mobilise the patient on Day 1
- Maintain drains until output <50ml/ 24hrs
- One commonly sees a transient increase in drainage output with immobilised patients once the patient starts to be mobilised
- Remove skin staples 2 weeks post-operatively

Clinical examples

Figure 23: ALT used for total glossectomy

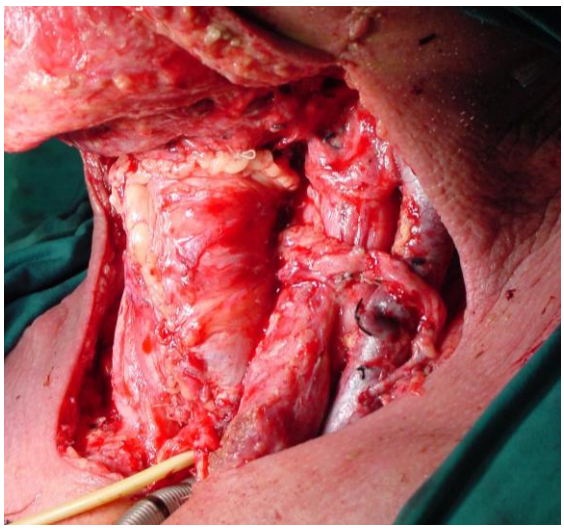


Figure 24: Tubed ALT flap used to replace hypopharynx and cervical oesophagus

Figure 25: ALT used for facial soft tissue defect; note inferior colour and texture match

Figure 26: ALT flap used for inferior maxillectomy defect

References

1. Yu P. Characteristics of the anterolateral thigh flap in a Western population and its application in head and neck reconstruction. *Head Neck* 2004;26: 759-69
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Other flaps described in *The Open Access Atlas of Otolaryngology Head & Neck Operative Surgery*

- *Pectoralis major flap*
- *Cervicofacial flaps*
- *Deltopectoral flap*
- *Buccal fat pad flap*
- *Buccinator myomucosal flap*
- *Nasolabial flap*
- *Temporalis muscle flap*
- *Submental Artery Island flap*
- *Supraclavicular flap*
- *Upper and lower trapezius flaps*
- *Latissimus dorsi flap*
- *Paramedian forehead flap*
- *Local flaps for facial reconstruction*
- *Radial free forearm flap*
- *Anterolateral thigh (ALT) free flap*
- *Rectus abdominis flap*
- *Free fibula flap*
- *Thoracodorsal artery scapular tip (TDAST) flap*
- *Gracilis microvascular flap*
- *Medial sural artery perforator (MSAP) flap*
- *Principles and technique of microvascular anastomosis for free tissue transfer flaps in head and neck reconstructive surgery*

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