35 Imaging and Surgical Principles for Tensor Fascia Lata Flap

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CONTENTS

35.1 INTRODUCTION

The tensor fascia lata (TFL) flap is one of the first described free flaps. It consists of the tensor muscle, the fascia lata, and the cutaneous coverage over the fascia. It is a type 1 muscle (Mathes & Nahai) with a single dominant pedicle known as the transverse branch of the lateral circumflex femoral artery and venae comitantes. The TFL is one of the most reliable and usually satisfactory flaps, due to its constant anatomy and the acceptable diameter and length of the vascular pedicle. The vascular pedicle gives three musculocutaneous perforators to nourish the overlying cutaneous region. Although the TFL muscle itself is too small, these perforators permit almost all the skin of the anterolateral thigh to be supplied, offering an extensive cutaneous territory, three times the size of the muscle. It may be used as a pedicled flap to adjacent defects involving the groin, vulva, perineum, sacrum, ischium, or trochanteric region or as a free flap for more distal reconstruction.

The TFL muscle was first used by Wangensteen in 1934 to reconstruct hernia defects as a pedicled flap without skin. It was used as a musculocutaneous flap by Baily in 1967 to cover acetabular defects. Surgeons such as Hill, Nahai, Bostwick, and McGregor and Buchan subsequently discovered a wide variety of applications in reconstructive surgery. Nowadays, it can also be used as a perforator flap, as described by Deiler in 2000 and Koshima in 2001.

35.2 REGIONAL ANATOMY

(Figure 35.1)

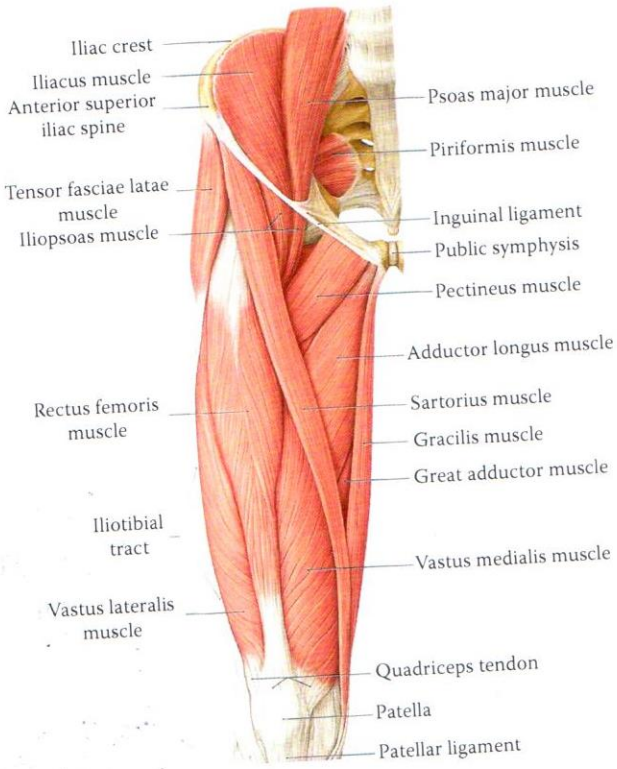


FIGURE 35.1 Regional anatomy and muscles of the thigh.

35.3 ARTERIAL ANATOMY OF THE THIGH

The femoral artery receives blood through the external iliac artery. This connection arises at the femoral triangle behind the inguinal ligament (Figure 35.2). After the femoral artery, known specifically as the common femoral artery, leaves the femoral triangle, it divides into superficial and deep (profunda) branches 2–4 cm inferior to the inguinal ligament. The adductor longus muscle serves as a separation between these branches. While the deep branches run posterolaterally to the adductor longus muscle, the superficial branch courses anterior to it. The deep femoral artery provides blood to the thigh, while the superficial femoral artery supplies blood to the arteries that nourish the knee and foot.

The deep femoral artery gives off the medial femoral circumflex artery and three perforating arteries when it runs posterior to the adductor longus muscle. The medial femoral circumflex artery gives off two branches, the ascending and descending branches, at the level of the upper border of the adductor brevis. The deep femoral artery generally has four perforating arteries, though this can range from 2 to 6. The lateral circumflex artery arises from the lateral side of the deep femoral artery 8–10 cm inferior to the anterior superior iliac spine (ASIS); runs transversally between the divisions of the femoral nerve, behind the sartorius and rectus femoris muscle; and then divides into ascending, transverse, and descending branches which supply the lateral and posterior thigh muscles. The ascending branch primarily supplies blood to the gluteus minimus muscle, and the transverse branch nourishes the TFL muscle, emerging through the anteromedial aspect of the muscle, while the descending branch supplies the vastus lateralis muscle.

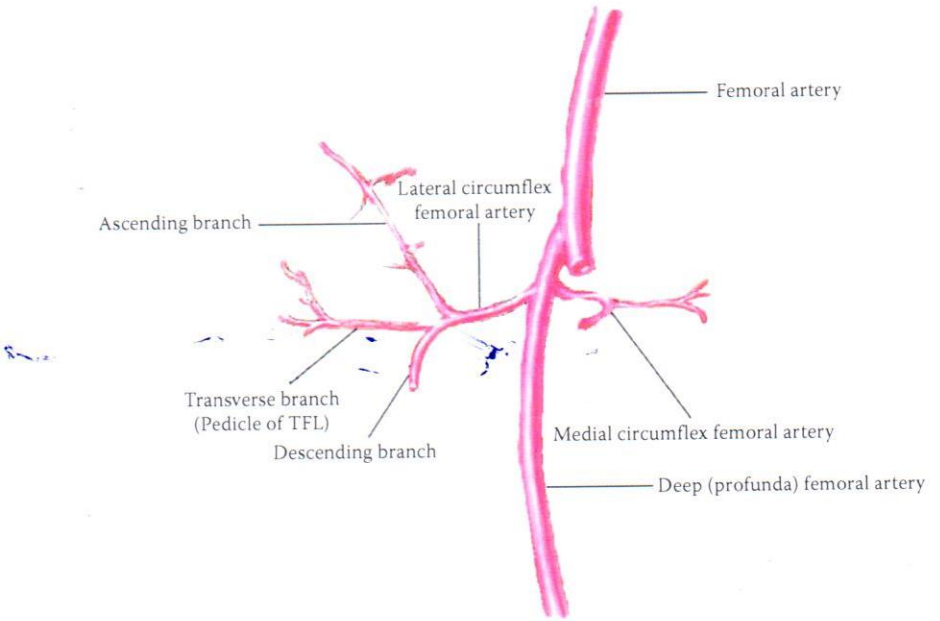


FIGURE 35.2 Arterial supply of the thigh.

The external diameter of the transverse branch of the lateral circumflex artery is 2–3 mm at its origin. Measured from its origin to the TFL muscle, the average length of the vascular pedicle is 4–6 cm in adults. It gives off three branches before emerging from the TFL muscle; superior, middle, and inferior. The superior branch supplies the proximal or upper one third of the muscle and neighbouring iliac bone at the origin of the muscle. The middle branch supplies the middle one third of the muscle, and the inferior branch supplies the lower third of the muscle and distal fascia.

Connections between the origin of the TFL muscle and outer lip of the anterior iliac crest permit transfer of the muscle with the bone as a vascularised bone flap based on the vascular pedicle of the muscle. The blood supply of the osseous segment is furnished by 2–3 small vessels emerging from the iliac bone through the muscle attachments.

Both the medial and lateral femoral circumflex arteries may rarely arise directly from the femoral artery.

The distal third of the thigh is also supplied by the perforating branches of the deep femoral artery.

35.4 VENOUS ANATOMY IN THE REGION

The venous system is usually through one or two venae comitantes which course with the arteries. The external diameter is approximately 2–4 mm at the level where the transverse branch connects to its main trunk. The lateral circumflex femoral vein then joins to the femoral vein (not the deep branch of the femoral vein or the profundus femoris vein), 2–4 cm inferior to the inguinal ligament.

35.5 NERVES IN THE REGION

The lateral femoral cutaneous nerve of the thigh is a nerve of the lumbar plexus which takes the form of the dorsal divisions of the second and third lumbar nerves (Figure 35.3). It enters from the lateral margin of the psoas major muscle at the level of its middle and runs in the pelvis beneath the iliac fascia, toward the ASIS. It then passes under the inguinal ligament 1–3 cm medial to the ASIS and over the sartorius muscle into the thigh, where it divides into an anterior and a posterior branch.

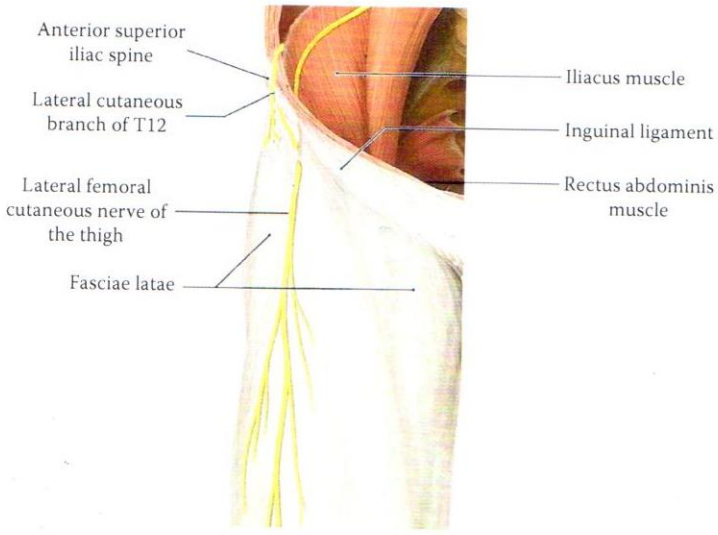


FIGURE 35.3 Sensorial territory of the overlying skin of the TFL muscle flap.

The anterior branch becomes superficial about 10 cm below the inguinal ligament and divides into branches which are distributed to the skin of the anterior and lateral parts of the thigh, as far as the knee. It measures 2–3 mm proximally and has 3–4 fascicles.

35.6 FLAP ANATOMY

The TFL muscle, located on the lateral side of the thigh, arises from the anterior part of the outer lip of the iliac crest between the gluteus medius and sartorius muscles (Figures 35.1 and 35.4). It extends 5 cm along the iliac crest toward the outer surface of the ASIS as a flat and

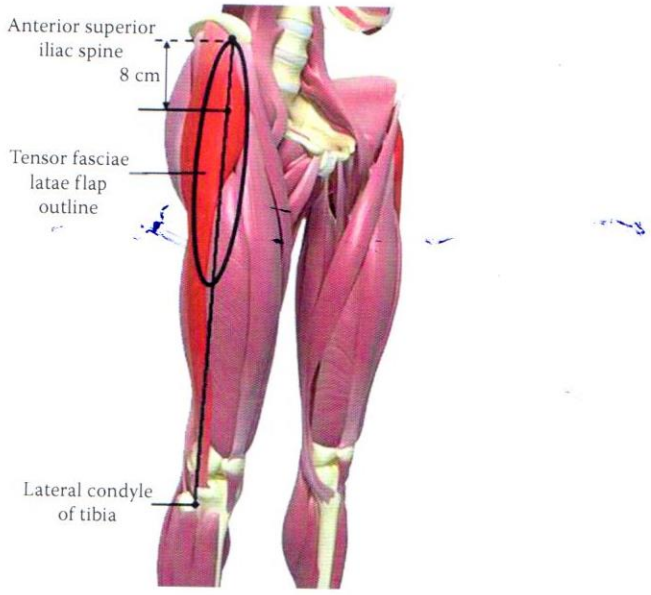


FIGURE 35.4 Anatomic landmarks for the TFL flap.

broad tendon. The muscle proceeds distally as a band-like aponeurosis and enters between two layers of the iliotibial band of the fascia lata approximately at the junction of the upper and middle thirds of the thigh. The muscle is small, broad, flat, and fish shaped. The average length is 13 cm, width 4 cm, and thickness 2 cm. The primary functions of the muscle are to provide stabilisation of the hip and lower extremity in standing posture; extension of the knee, as an accessory flexor of the thigh; and abduction of the hip. The TFL muscle may be sacrificed; it is not of primary functional importance since there are other muscles that can assume these functions.

35.7 ARTERIAL SUPPLY OF THE FLAP

(Figure 35.2)
The dominant artery is the transverse branch of the lateral circumflex femoral artery. There is no minor artery because of the type 1 muscle. The mean length of the pedicle is 5 cm (range 4–7 cm) and the diameter is 2.5 mm (range 2–3 mm). This artery divides into three branches, superior, middle, and inferior, before emerging from the muscle as mentioned earlier. However, while the ascending branch of the lateral circumflex femoral artery is the major vascular supply of the TFL flap in 10%–15% of the population, a vessel raised from the descending branch of the lateral circumflex femoral artery supplies the flap in 15%–20% of cases.

An average of 2–5 musculocutaneous perforators, measuring 0.8–1.0 mm in diameter, originate from the pedicle to supply the overlying anterolateral thigh skin. These perforators penetrate the muscle proximally and then run superficially to the fascia. More distally, fasciocutaneous perforators arise from either the descending branch of the lateral circumflex artery or the profunda femoris artery and also supply the distal skin of the thigh (within 4–6 cm of the knee). However, these fasciocutaneous perforators are not applicable to dissection based on the main vascular pedicle of the flap. Delay procedures and involving the fascia to the flap require elevating the flap in the caudal part of the thigh.

All three branches of the transverse branch of the lateral circumflex femoral artery send perforating branches into the skin. The perforator vessel runs in a posterolateral direction in adipose tissue after penetrating the deep fascia. It then divides into several branches in the middle of its course which run in a straight line to the subdermal plexus. The blood flow to the skin and lining of adipose tissue is supplied mainly by the perforator and partially by the capillary network in the adipose tissue. Aggressive thinning without leaving a large cuff of fat may sacrifice the blood circulation through this network, resulting in a less reliable area of skin.

35.8 VENOUS DRAINAGE OF THE FLAP

Generally, two venae comitantes of the transverse branch of the lateral circumflex artery provide the venous network of the flap. The mean length of the venae comitantes is 5 cm (range 4–7 cm) and the diameter 2.5 mm (range 2–3 mm). There are also small perforator vessels in the caudal thigh which join to the deep femoral vein. But this is not suitable as additional venous drainage for standard flap harvest.

35.9 FLAP INNERVATIONS

35.9.1 MOTOR

The superior gluteal nerve originates in the sacral plexus and arises from the ventral division of the fourth and fifth lumbar and first sacral nerves (L4–L5–S1). It exits the pelvis through the greater sciatic foramen and passes above the piriformis muscle. The nerve is accompanied by the superior

gluteal artery and vein. It runs laterally between the gluteus medius and minimus muscles, innervating both. It then emerges from the middle third of the TFL muscle from the posterior surface, 4–5 cm below the iliac crest.

35.9.2 Sensory

(Figure 35.3)
The skin of the TFL flap is innervated by two different sensory nerves:

1. Lateral cutaneous branch of the 12th thoracic nerve
2. Lateral cutaneous of the thigh (L2–3)

35.9.2.1 Lateral Cutaneous Branch of the 12th Thoracic Nerve

The nerve perforates the oblique externus and internus muscle in the anterior axillary line and descends over the iliac crest approximately 6 cm posterior to the ASIS. It is distributed to the skin overlying the iliac crest, the front part of the gluteal portion, or the proximal region of the TFL. It measures 2–3 mm in diameter proximally and involves 2–3 fascicles.

35.9.2.2 Lateral Cutaneous of the Thigh (L2–3)

It enters 1–3 cm inferomedially to the ASIS as detailed earlier and courses over the sartorius, penetrating deep fascia, to innervate the distal two thirds of the anterolateral aspect of the thigh.

35.10 FLAP COMPONENTS

The flap can be elevated as a musculocutaneous, osteomusculocutaneous, musculo-osseous, musculofascial, or skin-only flap.

35.11 ADVANTAGES

1. This flap has a long vascular pedicle with a suitable external diameter for vascular anastomosis.
2. The TFL has an extensive and reliable skin vascular territory.
3. The vascular pedicle is located between the vastus lateralis and rectus femoris muscles, and variation is rare.
4. It does not require positional changing during surgery for most patients, since the flap can be harvested with the patient in the supine position.
5. The TFL can be elevated as fasciocutaneous, musculocutaneous, fascia or muscle-only, osteomusculocutaneous, or musculo-osseous flaps and harvested under spinal or epidural anaesthesia.
6. A sensate flap can be obtained by captation of the lateral cutaneous part of T12 and/or the lateral femoral cutaneous nerve of the thigh to the skin portion of the flap.
7. A functional muscle flap can also be achieved by including a branch of the superior gluteal nerve (motor nerve).
8. The flap can be harvested as a perforator flap and thinned to 5 mm by sectioning the TFL muscle between the medial and superior branches of the distal lateral femoral artery.
9. Primary closure of the donor site is possible if the width of the skin flap is less than 8–9 cm, and it does not cause major functional deficit in the lower extremity when harvesting the TFL muscle flap.

35.12 DISADVANTAGES

1. The donor site may be unacceptable and difficult to conceal, especially in patients who require skin grafting for closure.
2. Unless the flap is elevated as a perforator-based flap, it may be bulky.
3. In rare cases, loss of TFL muscle can cause minimal loss of knee stability. When the cutaneous flap can be harvested suprafascially, this risk can be minimised.

35.13 FLAP DIMENSION

35.13.1 Muscle Dimensions

The width of the TFL muscle is 4 cm (range 3–5 cm) with an average length of 13 cm (range 12–15 cm). It is 2 cm thick (range 1.5–3 cm).

35.13.2 Skin Island Dimensions

The width of the cutaneous paddle is 10 cm (range 7–20 cm); length and thickness are 20 cm (range 15–40 cm) and 10 mm (range 5–20 mm), respectively. The length of the cutaneous flap can be extended beyond 10 cm proximal to the knee if a delay procedure is performed. Otherwise, there is no possibility of the distal portion of the flap surviving.

35.13.3 Fascia Dimensions

The length of the flap is 10 cm (range 5–30 cm), width 10 cm (range 6–20 cm), and thickness 2 mm (range 1–2 mm).

35.13.4 Bone Dimensions

The average length of the bone segment is 5 cm (range 4–8 cm), width is 4 cm (range 2–5 cm), and thickness is 12 mm (range 10–17 mm). The bone segment that incorporates the origin of the TFL muscle flap is included in the flap (Figure). The vascular pedicle of the osseous segment is provided by two to three small vessels emerging from the iliac crest through the TFL muscle, which is supplied by an ascending branch of the main pedicle.

35.13.5 Preoperative Preparation

The side of the flap chosen is determined by the recipient site or the defect to be reconstructed. A Doppler probe can be used according the type of the flap to decide on the most reliable artery and its course, such as harvesting the perforator-based flap. The thigh is prepared and scrubbed. Shaving the hair is usually optional and depends on surgeon's choice, the nature and length of the hair, and the recipient site.

For most cases, the area of the thigh, hip, and entire leg is prepared down to the level of the knee to facilitate hip and knee flexion when required.

Computed tomography (CT) and magnetic resonance (MR) imaging can be performed to ensure extension of the wound and reliability of the pedicle and the flap in the case of decubitus ulcer defects before surgery.

35.13.6 Flap Markings

A line is drawn from the ASIS to the lateral condyle of the femur to expose the vascular pedicle (Figures 35.4 and 35.5). The flap is outlined on the lateral aspect of the thigh; the anterior border corresponds to this line. A point, demarcating the vascular pedicle, is marked 8 cm (range 6–10 cm)

FIGURE 35.5 Flap markings.

caudal/inferior to the ASIS. This point also represents the central axis of the flap. The lateral femoral cutaneous nerve (also called the lateral cutaneous nerve of the thigh) emerges from the thigh below the inguinal ligament about 1–2 cm inferomedially to the ASIS and runs over the sartorius muscle into the thigh. A line 10 cm inferior to the ASIS at the anterior boundary of the flap represents the point for the lateral femoral cutaneous nerve of the thigh. The lateral cutaneous branch of the 12th thoracic nerve is located 6 cm posterior to the ASIS.

35.13.7 Patient Position

The patient is placed in the supine position to harvest the free flap and for the anterior arc of rotation or reconstruction of abdominal, inguinal, and trochanteric defects and in the prone position for the posterior arc of rotation or treatment of ischial and sacral defects. The lateral decubitus position can also be used for covering hip and ischial defects.

35.14 TECHNIQUE OF FLAP HARVEST

35.14.1 TFL Muscle Flap

(Figure 35.6)
An initial incision to elevate the flap can be made along the anterior, posterior, or distal border of the flap. If distal to proximal dissection is selected, the distal border of the flap is incised first.

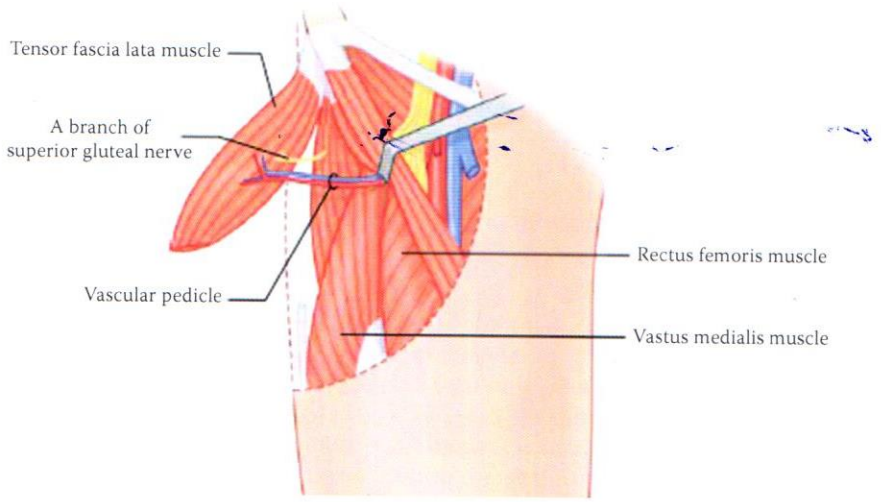


FIGURE 35.6 Harvest of TFL muscle flap.

The incision then continues along the anterior and posterior boundary of the flap. But generally, the anterior incision is performed first at the level of the ASIS or more anteriorly, depending on the size of the flap. The upper part of the incision is the plane between the sartorius muscle and the TFL. This incision shows the anterior border of the muscle. After the tensor fascia lata is identified, the fascia is incised at the level of the anterior–inferior border of the muscle, and the dissection is extended distally toward the knee. The fascia lata is divided from the aponeurotic attachment inferiorly, and the incision extends posteriorly. The TFL muscle is exposed and separated from its fascial extension from a distal to a proximal direction, which continues as the fascia lata. Several tacking stitches may be applied to preserve the musculocutaneous perforators. Dissection deep to the fascia lata overlying the vastus lateralis muscle is performed rapidly in a relatively bloodless field. The rectus muscle is exposed in the upper part of the incision and retracted medially to identify the neurovascular pedicle of the flap at the level of the middle third of the muscle between the rectus femoris and vastus lateralis muscles. When a pedicled flap is required, it is not necessary to pursue the dissection further proximally. If functional muscle transfer is planned, a branch of the superior gluteal nerve is identified between the gluteus medius and gluteus minimus muscles posterior to the vascular hilus. This should be carefully sought out at the posterior border of the muscle, 4–5 cm inferior to the iliac crest. Vascular branches of the gluteus minimus and vastus lateralis muscle are ligated, resulting in a pedicle length of 5–6 cm. Finally, the TFL muscle is completely freed from the vastus lateralis, rectus femoris, sartorius, and gluteal muscles. Dissection of the pedicle can be continued up to the profunda femoris artery to obtain more length when necessary. This can be achieved by further dissection to obtain a pedicle as long as 10 cm by ligating all branches, including the descending branch. During the dissection of the vascular pedicle, care should be taken deep to the rectus femoris muscle where the vessel is closely related to the muscular branch of the femoral nerve. For most purposes, it is not necessary to separate the origin of the muscle. However, to harvest a true island flap or to avoid a dog-ear deformity at the point of rotation, the origin of the muscle is divided from the iliac crest. The muscle flap is elevated based on its neurovascular pedicle.

To reduce flap bulk and donor site morbidity such as contour depression on the upper lateral region of the thigh, a small portion of the muscle can be elevated according to the defect requirement. This is achieved by preserving the superior, anterior, and posterior parts, including the muscle inferior to and around the vascular bundles.

35.14.2 Free Microvascular Transfer of the TFL Muscle Flap

The free microvascular muscle flap is elevated in the same manner. After cutting the pedicle, the flap is transferred to the recipient area.

35.14.3 TFL Musculocutaneous Flap

(Figure 35.7)

Markings are made similar to those mentioned earlier in muscle flap harvesting. All skin incisions are performed and extended down to the fascia lata. The flap is then elevated in the subfascial plane from distal to proximal dissection, at the level of the aponeurotic attachment of the muscle to the iliotibial tract. The skin flap is sutured to the fascia to prevent perforator damage. After the skin island is obtained, the muscle part of the flap is isolated based on its vascular pedicle. If a neurovascular flap is required, the lateral cutaneous nerve of the thigh is explored beforehand as described for the muscle flap, the appropriate length is decided on, and the nerve is sharply transected. The muscle is separated from its origin from the ASIS and iliac crest.

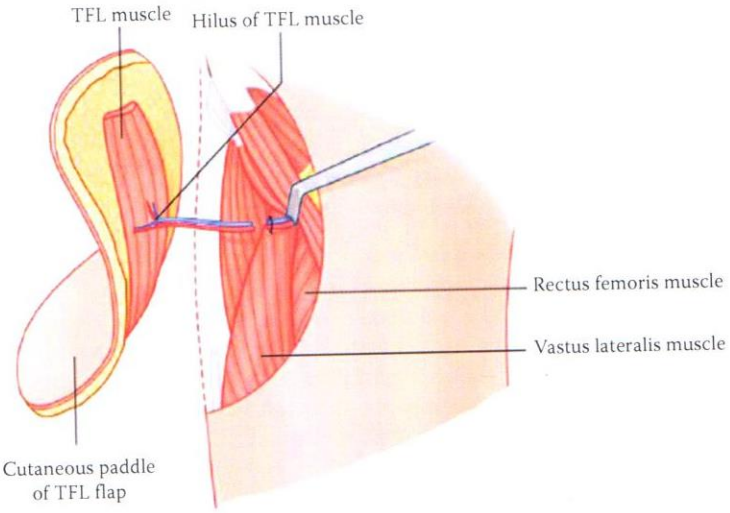


FIGURE 35.7 Harvest of TFL musculocutaneous flap.

35.14.4 TFL Osteomusculocutaneous Flap

(Figure 35.8)

An anterior segment of the iliac crest, connected to the origin of the TFL muscle and adjacent tissue, can be taken with the flap as a vascularised bone graft. The dissection is similar to those outlined earlier in the muscle or musculocutaneous flaps, with the exception that an upright incision proximal/superior to the ASIS might be involved to identify the osseous segment of the flap. Nourishment of the bony segment is from the periosteum at the muscle origin. After the vascular pedicle is isolated, ostomies are performed to elevate a segment of iliac bone without dividing the muscle origin from the iliac crest. Harvest of osseous segment is easier after ligation of the vascular pedicle.

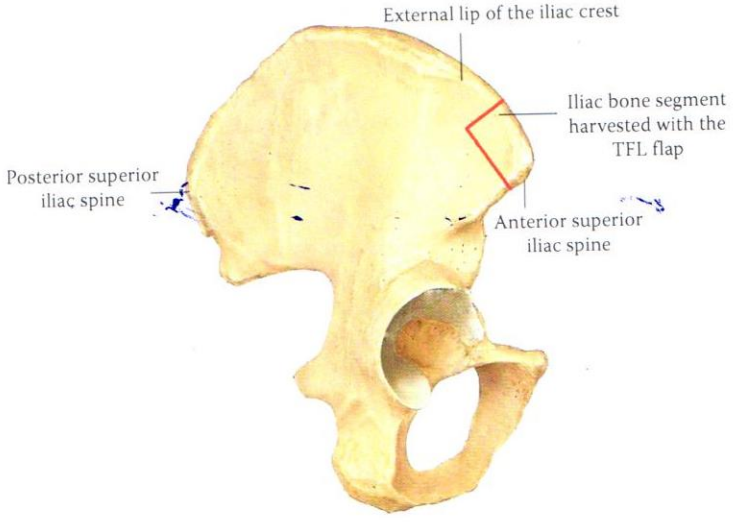


FIGURE 35.8 Section of iliac bone which can be harvested with the TFL flap.

35.14.5 Musculofascial Flap

If cutaneous coverage is not necessary, the TFL musculofascial flap may be harvested. The fascia lata is elevated with the muscle. A skin incision is performed from the ASIS to the knee along the midlateral point of the thigh. The skin is reflected on each side, and the fascia lata is exposed. The width and length of the fascia harvest are determined on the basis of the required flap size. The fascia lata is then incised and dissected as usual in a distal to proximal direction. However, a pure fascia flap without the muscle or cutaneous unit is not a reliable flap technique.

35.15 FLAP MODIFICATIONS/FLAP HANDLING

35.15.1 Transverse

35.15.1.1 Skin Island

An elliptical island marked in a horizontal manner is oriented on the vascular pedicle. This has been described for breast reconstruction. The skin island is centred transversely extending from the lateral thigh to the buttock. The superior boundary of the flap island is several centimetres below the iliac crest. The lower border is planned depending on the reconstructive needs. But this design is not to be preferred on account of unacceptable donor site appearance.

35.15.1.2 Osseomuscular or Osseomusculocutaneous Flap

An osseomusculocutaneous flap involving the outer side of the iliac bone at the origin of the muscle may be harvested in dimensions of 5 cm × 4 cm.

35.15.1.3 Extended Skin Island

This flap is much wider and longer than the standard flap. Planning of the cutaneous flap can be extended to 4 cm above the lateral femoral condyle, but the width of the flap should not be greater than 10 cm at the most distal level. The flap elevation is essentially the same as for the standard flap. Tissue expansion or flap delay is required for longer flap harvest. But the fascia lata must be involved with the skin flap at the distal level to prevent flap failure.

35.15.1.4 Delayed Flap

Delay procedures must be performed if a longer flap harvest than an extended skin island is required. This is usually achieved in the estimated distal margin of the flap. After the distal borders of the flap are incised, the dissection is continued subfascially, and finally, ligating small perforators from the main pedicle will increase flap survival.

35.15.1.5 Tissue Expansion

Tissue expansion makes it possible to increase the standard flap dimensions and functions as delay procedures. An expander should be placed under the fascia lata by a small incision anteriorly or posteriorly at least 2–3 cm away from (inferior to) the vascular pedicle. After the dissection is completed and homeostasis is achieved, the expander is located. Intraoperative expansion is performed minimally, depending on the volume of the expander. The expansion process is initiated 1–2 weeks postoperatively. Overexpansion is generally useful to achieve reasonable outcomes.

35.15.1.6 Neurosensorial Flap

The TFL is a good neurosensory flap option for local transfer or distant microvascular transplantation. The lateral femoral cutaneous nerve of the thigh (L2–L3) or the lateral cutaneous branch of T12 may be involved with the flap.

35.15.1.7 Functional Muscle Flap

The TFL muscle flap can be used as a dynamic functional flap. The branch of the superior gluteal nerve must be involved with the muscle flap for this purpose. It is preferred for upper extremity dynamic reconstructions, such as shoulder or elbow deficits. The maximum excursion of the muscle when properly sited is about 3 cm, and the muscle contractions can be shorted by an average fascicle length of 40%.

35.15.1.8 Chimeric Flap

Chimeric flaps can also be harvested based on the vascular pedicle of the TFL at the mid-part of the thigh and, more caudally, elevated based on the subcutaneous pedicle that is proximally supplied by the same pedicle. It permits mobilisation of the flap in many different planes. Each part of the flap may be transferred freely to cover more severe complex defects. This modification is reduced due to donor site morbidity, and more satisfactory aesthetic results can be achieved after flap inset due to pliability of the subcutaneous tissue. It may also be possible to harvest the vastus lateralis muscle pedicled on the descending branch of the lateral circumflex femoral artery with the chimeric TFL flap to obtain extensive volume and larger dimensions and also to give two units.

35.15.1.9 Perforator Flap

Perforators run in the posterolateral direction in fat tissue after penetrating the deep fascia. The diameters of these musculocutaneous perforators are 0.5–1 mm. Microdissection follows through the TFL muscle up to the transverse branch of the lateral circumflex femoral artery. After reaching the transverse branch of the artery, dissection proceeds up to the main trunk, the transverse branch is ligated, and finally, the perforator flap is elevated based on this vascular pedicle to use as a free or pedicled flap. The pedicle is longer than the musculocutaneous flap, with a mean length of 8 cm (range 7–10 cm). The adipose tissue of the skin flap is covered with deep fascia, which is trimmed sharply away from the perforator. This provides a thinned flap up to 5 mm. The disadvantage of this procedure is that it requires meticulous dissection and considerable experience. It is not always necessary to use Doppler USG to identify the perforator.

35.15.1.10 V–Y Advancement Flap

The V–Y advancement flap covers defects of the greater trochanter.

35.15.1.11 Special Instruments

Standard surgical instruments are adequate for the elevation of the pedicled musculocutaneous flap. However, microsurgical instruments, an operating microscope, and loupe magnification are required for the harvest of free or perforator flaps.

35.15.1.12 Donor Site Closure

Primary closure of the donor site is achieved when the width of the cutaneous flap is less than 6–8 cm. Otherwise, the donor site requires split-thickness skin graft closure. Before suction drains are placed, careful homeostasis to bleeding from the adjacent muscles is performed. Two-layer closures are then performed. Compression over the pedicle should be avoided when inserting the drains and applying the dressing. If even a small part of intact fascia is left in the donor site, this should be sutured back in an appropriate manner to preserve knee stability.

35.15.1.13 Precautions and Technical Tips

1. Donor site closure under tension should be avoided since this may lead to a compartment syndrome within the lower extremity.
2. Caution is advised, because the distal skin portion may be unreliable if extended too far Flap delay or expander insertion is required.

3. The location of the vascular pedicle is not always constant; it may be found between 8 and 12 cm inferior to the ASIS. This should therefore be kept in mind during harvesting.
4. Elevating an osseous segment from the iliac bone may lead to contour deformity and possible herniation of the abdominal wall.
5. The superior gluteal nerve should be preserved during the flap dissection.
6. If a sensory flap is required, ultra-thinning of the flap should be avoided because of sensory nerve damage.
7. Injection of local anaesthesia over the proximal course of the lateral femoral cutaneous nerve is a very useful method in mapping the territory of the nerve if elevating a neurosensory flap.
8. The muscle attachment can be separated from the iliac crest to increase the arc of rotation of the flap and to avoid dog-ear formation.

35.16 FLAP USE

35.16.1 Pedicled

The TFL is used as a fascia–skin or the muscle–fascia–skin flap for reconstruction of defects in the

Groin
Ischium
Perineum
Lower abdomen
Sacrum
Trochanter

The pivot point of rotation of the flap is 10 cm below the ASIS that enters the vascular pedicle. Posterior and anterior arcs of rotation can cover the greater trochanter, ischium, perineum, and sacral area and the abdominal wall, groin, vulva, and perineum, respectively. Anterior rotation can extend to the xiphoid and the contralateral iliac bone. The TFL is an excellent choice for soft tissue closure of abdominal, trochanteric, ischial, perineal, and sacral defects. The fascia lata can provide additional fascial support for abdominal wall integrity. But in large abdominal defects or if there is an insufficient arc of rotation, a free TFL should be carried out. This flap is also used for penile reconstruction as a pedicled flap. The dimensions of the peninsular design as a rotation flap are 10–12 cm × 15–17 cm, but this can be up to 10–12 cm × 23–25 cm when the flap is designed as a free or island flap.

35.16.2 Microvascular Free Flap

The vascular territory of the TFL supplies a very large and reliable skin and muscle area. It is used as a free flap as described in the following:

Upper and lower extremity
Head and neck
Functional reconstruction
Upper abdominal wall reconstruction
Breast reconstruction

The standard TFL flap for closure of head and neck defects is not suitable where a thin flap is required involving intraoral mucosa defects and skin-only defects. But in composite or through-and-through defects, it may be an ideal option.

Osseomuscular or osseomusculocutaneous flaps are preferred for both bony and soft tissue repair, such as maxillofacial and long-bone reconstruction.

Functional muscle flap may be used for reconstruction of functional deficit in the extremities. The best options as an innervated flap are the restoration of knee extension, shoulder abduction, elbow flexion, and Achilles reconstruction. It can also be used for functional restoration of extensive tongue defects.

A neurosensory flap is also used as sole covering by including one or two sensory nerves to the flap.

The TFL perforator flap may be used either free or pedicled. As mentioned earlier, the TFL muscle is left intact in this modification to prevent excessive flap bulk and reduce donor site morbidity. The free TFL perforator flap is a good option for tendon coverage and reconstruction.

35.17 ATYPICAL INDICATIONS FOR THE USE OF THE FLAP

35.17.1 Pedicled

Penis reconstruction with an extended flap

35.17.2 Free

Maxillofacial and extremity bony reconstruction
Breast reconstruction with transverse skin island

35.17.3 Postoperative Care

Clinical observation is best for flap monitoring. This should be done hourly for the first 2 days after free TFL flap reconstruction. No medication for flap viability is given in our department. We use only antibiotics, pain medication, and fluid management. We recommend continuous heparin infusion in the postoperative period in heavy crush injuries and in patients undergoing flap re-exploration. Depending on the reconstructed site, in our clinic, the patient is usually kept in bed for 2–3 days and then mobilised. The supine position is preferred if the flap is placed on the ventral body surface or the extremities. The reconstructed extremity is slightly elevated. The prone or lateral decubitus position is recommended for dorsal flaps involving the ischial or sacral area for 12–15 days. The supine or lateral decubitus position is used for reconstruction of the trochanteric region.

The patient is discharged after 1 week postoperatively. However, this may be longer in cancer patients and patients with poor general condition.

35.17.4 MRI Appearance of the Tensor Fascia Lata Muscle

The tensor fascia lata muscle is clearly visible in routine MR images (Figure 35.9). It originates from the iliac crest, and its fibres run downward and slightly backward. Distally, the fibres are inserted into the iliotibial tract. The fibres appear isointense to the other muscles in the thigh, whereas the fascia lata is hypointense in all MR imaging sequences, since it is a dense fibrous tissue (Figure 35.10). Arteries and veins are usually seen as hypointense tubular structures in T2-weighted images. However, routine sequences are usually not sufficient for the visualisation of muscular perforators.

35.17.5 Demonstration of Vascular Pedicle and Perforators

CT or MR angiography techniques can be used for the demonstration of vascular pedicle and perforators.

CT angiography should be performed on multislice scanners, preferably at 64 or more slices. Iodine-based contrast materials are injected via antecubital veins, and bolus tracking techniques are necessary to achieve optimal enhancement and visualisation of the arteries.

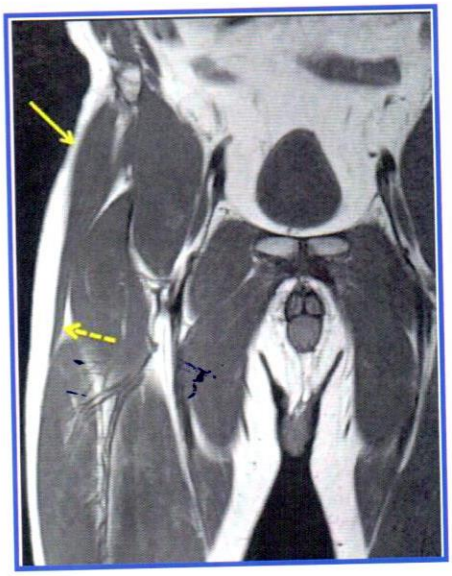


FIGURE 35.9 T1-weighted coronal MR image. The arrow shows the belly of the tensor fascia lata muscle. The dashed arrow shows the distal part of the muscle before insertion.

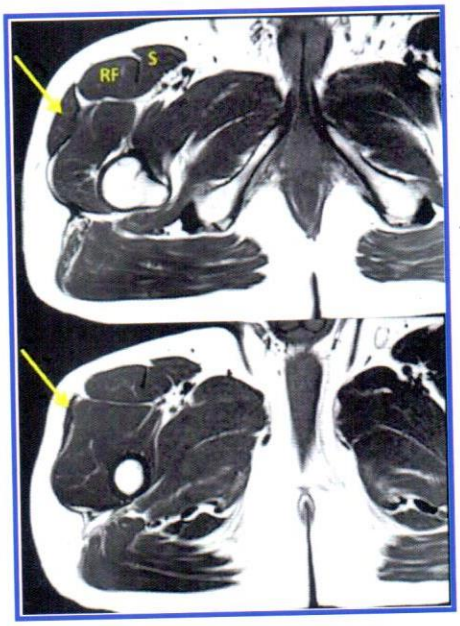


FIGURE 35.10 T1-weighted transverse MR images. The upper image is at the level of ischial tuberosity just below the iliac crest. The arrow shows tensor fascia lata muscle; RF, rectus femoris; S, sartorius muscle medial to the tensor fascia lata. Lower image, the arrow shows the distal part of the muscle before insertion to the fascia lata.

After obtaining the image data, reformatted images, such as multiplanar reformats and maximum and minimum intensity projections, are produced on workstations. At CT angiography, small perforators can be visualised better than with MR angiography (Figure 35.11). The soft tissue contrast is worse than with MRI. It also uses ionising radiation, which can be considered as another disadvantage.

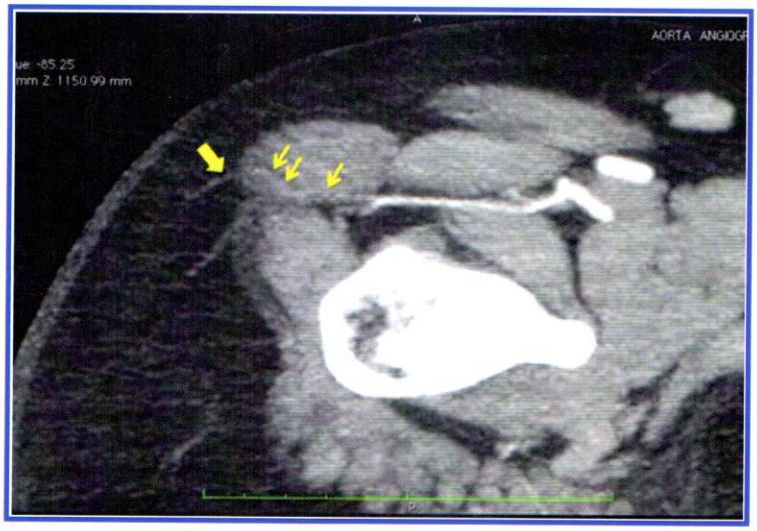


FIGURE 35.11 CT angiography, axial reformatted multi-planar reformatted (MPR) image showing the intramuscular (small arrows) and subcutaneous (large arrow) course of the perforator.

At MR angiography, breath-hold images are produced after obtaining localising scans. For the optimal enhancement of the arteries, accurate timing is necessary during the contrast injection. Fluorotriggering methods are used for this purpose. When optimal enhancement of the arteries within the area of interest is reached, the MR angiography sequence is started manually. After obtaining the image data, post-processing is performed on workstations, and 3D maximum intensity projection (MIP) images are produced. It is usually difficult to show small perforators at MR angiography. Perforator arteries may be visualised in routine MR sequences, such as T1- or T2-weighted spin echo/turbo spin echo. Additionally, 3D T2-weighted gradient echo sequences may be valuable for demonstrating small perforators (Figure 35.12). In this technique, contrast injection is not used, and vessels appear as bright linear intensities passing through muscles.

It is also possible to place external markers (such as fish oil capsules for MRI) to locate and mark perforators relative to the anterior superior iliac crest (Figure 35.13).

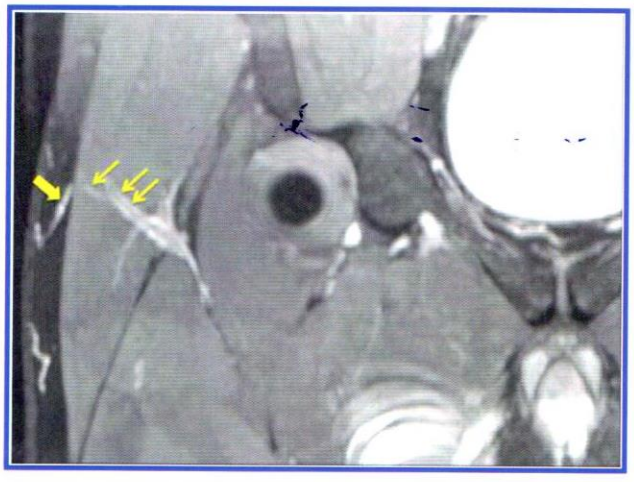


FIGURE 35.12 T2-weighted 3D gradient echo MR image (coronal MPR) showing the intramuscular (small arrows) and subcutaneous (large arrow) course of the perforator.

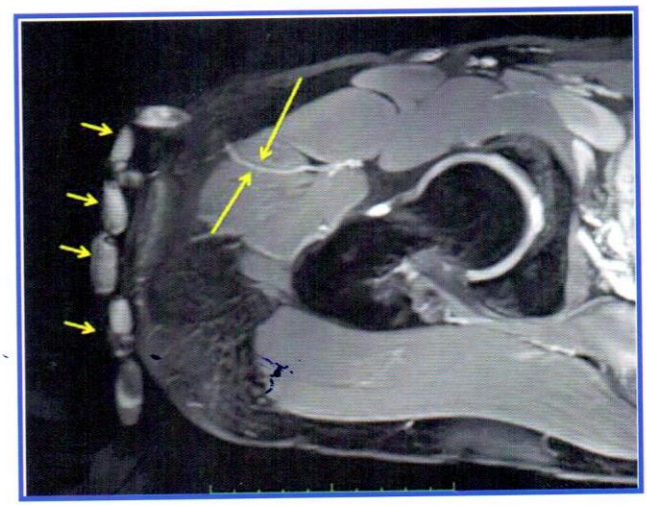
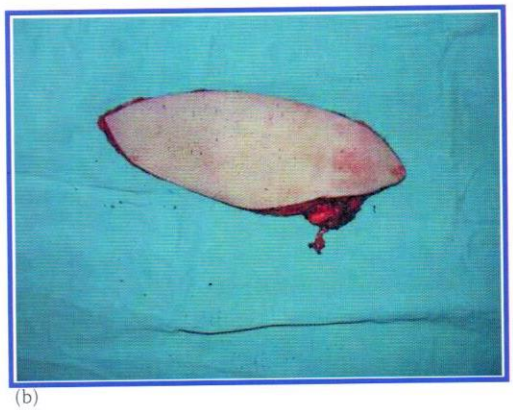


FIGURE 35.13 T2-weighted 3D gradient echo MR image (axial MPR) showing the intramuscular (long arrows) course of the perforator. Small arrows show fish oil capsules used for marking.

(a)



(b)

(c)

FIGURE 35.14 Extensive composite soft tissue loss of the right lower extremity. (a) Preoperative view. (b) TFL flap after harvest. (c) Postoperative view at 12 months.

35.17.6 Case Examples

Case 1: Extensive soft tissue reconstruction with exposed tibia of a lower extremity with a TFL myofasciocutaneous flap

A 44-year-old man suffered a traffic accident, which resulted in a composite tissue defect of the medial and distal anterior aspects of the lower extremity (Figure 35.14a). After sufficient debridement, a TFL flap (14 cm × 33 cm) was harvested (Figure 35.14b) and used to cover the defect (Figure 35.14c). The pedicle was anastomosed to the posterior tibial vessels. The donor area defect was closed using a split-skin graft. Postoperative recovery was uneventful.

Case 2: Subcutaneous pedicled TFL myocutaneous flap for reconstruction of a trochanteric decubitus ulcer

A 56-year-old paraplegic patient had a large trochanteric decubitus ulcer of 11 months duration (Figure 35.15a). A pedicled TFL flap (11 cm × 18 cm) was designed to close the defect (Figure 35.15b). The flap was rotated posteriorly, and the donor area was closed primarily (Figure 35.15c). Postoperative recovery was uneventful.

FIGURE 35.15 A left trochanteric decubitus ulcer in a 56-year-old patient. (a) Preoperative view. (b) The subcutaneous pedicled TFL flap design. (c) Postoperative early view.

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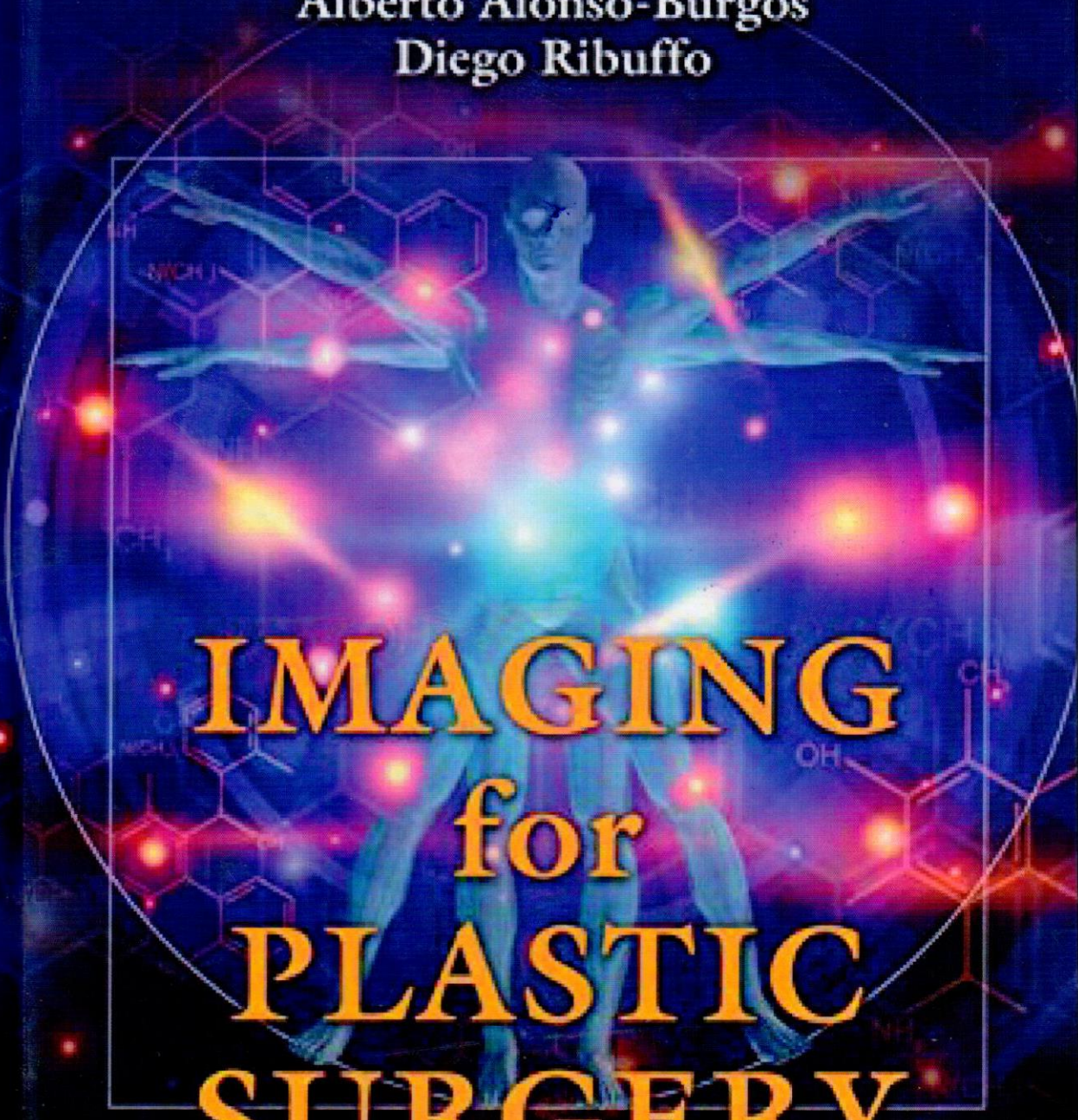

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