Chapter 1
The Deltoid Fasciocutaneous Flap

The deltoid free flap is a neurovascular fasciocutaneous tissue, providing relatively thin sensate tissue for use in soft-tissue reconstruction. The deltoid fasciocutaneous flap was first described anatomically and applied clinically by Franklin.\(^1\) Since then, the deltoid flap has been widely studied and applied.\(^2\)–\(^5\) This flap is supplied by a perforating branch of the posterior circumflex humeral artery and receives sensation by means of the lateral brachial cutaneous nerve and an inferior branch of the axillary nerve. This anatomy is a constant feature, thus making the flap reliable. The ideal free deltoid flap will be thin, hairless, of an adequate size, and capable of sensory reinnervation. These characteristics of the flap make it an attractive option for reconstructing defects of the orofacial region. However, in adipose individuals, the fat tissue might add to the bulk of the flap.

Preparation

The course of the neurovascular pedicle is determined and marked before surgery as follows. With the patient in sitting or standing position, the acromion and the lateral humeral epicon-
dyle are palpated and marked. A straight line is marked to connect these two landmarks. The groove between the posterior border of the deltoid muscle and the long head of triceps is palpated and marked. The intersection of these two lines denotes approximately the location of the vascular pedicle, as it emerges from underneath the deltoid muscle. This point may be studied with a hand-held Doppler and marked if required.

Depending on the recipient area, the patient is positioned either supine, with the donor shoulder sufficiently padded with a stack of towels, or in the lateral decubitus position. Myorelaxants are required in muscular individuals, so as to ease retraction of the posterior border of the deltoid muscle, especially if a long vascular pedicle is required for reconstruction.

Neurovascular Anatomy

A large portion of the fasciocutaneous territory overlying the deltoid muscle is nourished by the posterior circumflex humeral artery with its paired venae comitantes (Fig. 1.1). The sensory innervation of this skin area is through the lateral brachial cutaneous nerve, which is the terminal sensory branch of the axillary nerve, a musculocutaneous nerve arising from the posterior cord. This nerve accompanies the vascular pedicle, passing behind the humerus and emerging from the quadrangular space, which is bordered by the teres major muscle below,

![Fig. 1.1](image-url) Anatomical basis of the deltoid flap.

*aus: Krishnan, An Illustrated Handbook (ISBN 9873131477613) @ 2008 Georg Thieme Verlag KG*
Fig. 1.2  Planning markings of the deltoid flap.

Fig. 1.3  Dissection of the deltoid flap.

teres minor muscle above, long head of triceps medially, and the lateral head of triceps laterally. The vascular pedicle gives off branches to the deltoid muscles before its emergence. The nerve, as already mentioned, is a musculocutaneous nerve and provides motor innervation to the deltoid muscle. The neurovascular pedicle emerges at the posteroinferior border of the deltoid muscle, turns cranially after its emergence, and supplies the skin overlying the posterolateral aspect of the deltoid muscle. Thus a safe flap will be carved behind the line connecting the acromioclavicular joint and the lateral epicondyle, with an adducted and internally rotated arm (Fig. 1.2).

Incisions and Dissection

With the patient’s arm adducted and internally rotated, three lines are drawn: a line connecting the acromion and the lateral epicondyle, a line along the groove between the posterior border of the deltoid muscle and the long head of triceps, and a line connecting the acromioclavicular junction with lateral epicondyle. The intersection of the first two lines denotes the point where the vascular pedicle emerges to the surface behind the deltoid muscle; whereas the third line should ideally be the anterior border of the planned skin flap. Any variation in the point of emergence of the vascular pedicle can be marked before surgery using a handheld Doppler.

The anterior border of the marked skin flap is incised first, extending it along the inferior border as required. The deep fascia overlying the deltoid muscle is sharply cut and the flap is elevated in a plane underneath the fascia. Dissection proceeds toward the vascular pedicle, which is visualized in the under surface of the flap, after partially raising it (Fig. 1.3). An occasional perforator from the deltoid muscle should be coagulated and divided. The neurovascular pedicle is traced to the delto-tricipital groove and carefully isolated. Now the rest of the skin incision can be completed (Fig. 1.4). The posterior border of the deltoid muscle is retracted to gain length of the vascu-
Chapter 7
The Tensor Fasciae Latae Muscle Flap

The tensor fasciae latae muscle arises from the anterior part of the outer lip of the iliac crest and is invested in a double fascial layer. These fascial layers blend at the junction between the upper and the middle thirds of the lateral aspect of the thigh and course down as the ilio-tibial tract to insert into the lateral femoral condyle. The muscle flexes and rotates the femur internally.

The muscle is provided with a constant blood supply through one reliable vascular pedicle arising from the lateral circumflex femoral artery and its accompanying vein. The motor innervation is through the descending branch of the superior gluteal nerve. The overlying skin has two sources of sensory innervation: (1) the cutaneous branch of the T12 segment (upper part), and (2) the lateral femoral cutaneous nerve (lower part).

The tensor fasciae latae was first described as a free musculocutaneous flap by Hill, Nahai, and Vasconez in 1978. This musculocutaneous unit can be transferred with motor as well as sensory innervation; there are ample and different types of tissue that may be transferred based on the vascular pedicle of this muscle.  

These properties make the tensor fasciae latae muscle a very reliable workhorse for dealing with various reconstructive challenges.

Preparation

If not otherwise dictated by the site to be reconstructed, the patient is positioned supine with the hip and knee joints gently flexed. The thigh is rotated internally, so that its lateral aspect faces the surgeon (Fig. 7.1). The anterior superior iliac spine and the iliac crest are palpated and marked. The line joining the lateral most aspect of the iliac crest and the lateral femoral condyle marks the course of the iliotibial tract.

The position of the patient is determined by the area to be reconstructed. For instance, in using the tensor fasciae latae muscle as a pedicled rotation flap for the reconstruction of decubitus wounds, the patient may be positioned either on the side or in a prone posture.

Neurovascular Anatomy (Fig. 7.2)

The vascular pedicle that nourishes the tensor fasciae latae muscle arises either from the lateral circumflex femoral artery or, in some cases,
directly from the profunda femoris artery as an ascending branch. The pedicle enters the muscle belly ~6–8 cm distal to the muscle’s origin from the iliac crest. The skin overlying the muscle is richly vascularized by about four or five perforator vessels arising from this vascular pedicle.

The motor innervation is executed from the dorsal aspect through the descending branch of the superior gluteal nerve. The sensory innervation of the overlying skin is accomplished by the cutaneous branch of T12 that enters the lateral thigh region after crossing the iliac crest, and by the lateral femoral cutaneous nerve that enters the anterior border of the lateral thigh skin ~10–12 cm distal to the origin of the tensor fasciae latae muscle.

The vascular pedicle as well as the motor and sensory nerves can be reliably dissected by orienting oneself on the landmarks as described later.

**Incisions and Dissection**

The iliac crest, the anterior iliac superior spine, as well as the lateral femoral condyle are palpated and marked. A straight line joining the lateral-most aspect of the iliac crest and the lateral femoral condyle mark the approximate course of the musculofascial tract (Fig. 7.3). Moreover, the muscle belly is palpated and marked. If needs be, practically the whole of the skin of the lateral thigh may be raised along with the underlying muscle and fascia based on the single vascular pedicle.

A skin island centered along the tensor fasciae latae muscle belly is described here. Two points, 8 and 10 cm distal to the iliac crest and along the anterior muscle border, are marked. These represent the entry points of the vascular pedicle and the lateral femoral cutaneous nerve, respectively.

The anterior border of the skin flap is incised first, extending the incision in a lazy-S pattern proximally and distally as found necessary. Care is taken to preserve the lateral femoral cutaneous nerve that appears along the incision.

After the anterior border of the tensor fasciae latae muscle has been identified and dissected free, the muscle belly is retracted laterally and dorsally to reveal the entry point of the vascular pedicle (~6–8 cm distal to the muscle origin). These vessels travel in the septal space between the rectus femoris (anteriorly) and vastus lateralis muscle (posteriorly). Thus the rectus femoris is separated bluntly from the septal space and retracted anteromedially to visualize the course of the vascular pedicle (Fig. 7.4).

Now the posterior incisions of the skin island are completed, taking care to preserve the cutaneous nerve entering the skin island laterally along the iliac crest. The iliotibial tract is dissected and transected as distally as needed.

If the recipient site demands the transfer of a functional muscle, the dissection of the motor nerve is performed as follows: the posterior border of the muscle is freed sharply cut from the fascial attachments and the muscle is retracted anteromedially (Fig. 7.5). The gluteus medius muscle that inserts into the greater femoral trochanter is retracted posteriorly to reveal the motor nerve innervating the tensor
fasciae latae muscle. This nerve courses between the piriformis (anteriorly) and the gluteus medius muscle (posteriorly). The nerve is now stimulated and transected after confirming the motor response from the muscle flap.

After the muscle or musculocutaneous flap has been cut, the vascular pedicle is followed to its origin, retracting the rectus femoris muscle anteromedially. The artery and veins are transected separately between ligating clips.

The vascular pedicle is ~6–8 cm in length; the vessel diameters are in the order of 2–2.5 mm (artery) and 3 mm (vein). Based on this single vascular pedicle it is possible and reliable to raise the whole of the iliotibial tract along with the overlying skin (~40 × 20 cm). The motor nerve is 1–1.5 mm in diameter and is relatively short in length (approx. 5 cm).

Disadvantages associated with raising a large tensor fasciae latae musculocutaneous flap include muscle herniation and a long scar. Skin grafting may be necessary, where a broad skin flap has been cut.
Pitfalls
Dissection of this usually reliable flap may be demanding when an innervated flap has been planned. Particular care is necessary during the posterior dissection, where the motor nerve runs. It is surprisingly easy to transect the innervating nerves, since these are relatively small in caliber and short in length. Some situations may demand a nerve graft between the donor nerve at the recipient site and the motor nerve of the flap, owing to the limited length of the motor nerve. In our experience results after transferring functional muscle flaps were better when no nerve grafts were used.

It is safe to transfer this flap without motor innervation. Recipient sites that definitively demand a motor innervated muscle may be better treated with the gracilis or latissimus dorsi muscle flaps instead of the tensor fasciae latae muscle.

References


Chapter 11
The Dorsalis Pedis Flaps

The medial three toes, their metatarsals as well as the dorsal skin of the foot, are nourished by the dorsalis pedis artery. Thus any of these structures, separately or combined, may be raised on the basis of the dorsalis pedis artery and the saphenous veins. Furthermore, it is possible to raise a skin flap based on the distal communications of the dorsalis pedis artery with the deep plantar arch.

As early as 1967, Young described reliable transfer of the second toe for thumb reconstruction in the Chinese language. However, it was not until two years later that the free toe transfer was reported in English.

The dorsum of the foot offers thin, pliable, and reliably vascularized skin that also provides the option of using it as a neurosensate flap. Starting from narrow strips (for finger reconstruction) ending with almost the whole dorsum of the foot may be favorably transferred, based on the dorsalis pedis vessels, to meet different reconstructive challenges, especially of the hand. However, this flap has gained notoriety owing to the healing problems it leaves behind at its donor site.

Preparation

The positioning of the patient may be varied according to the approach to the recipient area, from supine to lateral decubitus. A strip of rolled soft gauze-cloth is used to grasp the first two toes in the manner shown in Figure 11.1 and the foot pulled to a more favorable plantar flexion. It is a good idea to apply a tourniquet to the thigh in a non-exsanguinating manner, so as to ease dissection of the subcutaneous veins.

Neurovascular Anatomy (Fig. 11.2)

The dorsalis pedis artery, the continuation of the anterior tibial artery, passes forward from the ankle-joint, lying beneath the retinaculum, along the tibial side of the dorsum of the foot to the proximal part of the first intermetatarsal space. Here it bifurcates into the first dorsal metatarsal and the deep plantar arteries, establishing communication with the deep plantar arch. At the level of the ankle this artery borders with the extensor hallucis longus from the tibial side, and with the first tendon of the extensor digitorum longus and the deep peroneal nerve from the fibular side. In a small minority of patients the dorsalis pedis artery may arise from the perforating branch of the deep peroneal artery. In these cases the flap pedicle remains short. The artery is accompanied by two comitant veins.

Infrequently the dorsal artery of the foot may be larger than usual, mostly to compensate for a deficient plantar artery; or its terminal branches to the toes may be absent, the toes then being supplied by the medial plantar. These anatomical variations are broadly classified under three types as shown in Figure 11.2. These variations do not play a role in raising the flap alone from the foot dorsum for free transfer. However, they have to be considered while planning a free toe transfer, or raising a distally based skin flap.

The greater and the lesser saphenous veins course along the tibial and the fibular aspects of the dorsal foot, respectively, receiving tributar-
Fig. 11.2  Neurovascular anatomical basis of the dorsalis pedis flap.

Fig. 11.3  Dissection of the dorsalis pedis flap.
Chapter 18
The Scapular Skin Flap

The scapular cutaneous flap was one of the earliest free flaps to be clinically applied. The subscapular artery branches off the third part of the axillary artery, as we have already seen in the description of the latissimus dorsi and serratus anterior muscle flaps. It is one of the vessels with minimal, or practically no, variability of its consistent thoracodorsal and other arterial branches. Gilbert performed early cadaver dissections, isolating oblique skin territories based on the circumflex scapular arterial system, and later applied the knowledge clinically. Others followed suit and delineated the characteristics of the cutaneous branches of the circumflex scapular artery more clearly, so that the territories of its two largest terminal branches were described. This led to the formation of the transverse and oblique scapular cutaneous flaps, the latter also being called the “parascapular” flap. Further, other components, such as bone from the lateral border of the scapula and deep fascia overlying the back muscles, were added to the original cutaneous flap, making the scapular and parascapular flaps a more versatile option. Additionally, the scapular flaps offer the possibility of combining them with other muscular and bone flaps, all based on the subscapular vascular pool.

The scapular flap is a popular option among reconstructive surgeons, owing to its easy harvest, reliable and large caliber microvascular pedicle, as well as the availability of compound neighboring tissue blocks that may be raised with it.

Preparation

The scapular flap is advantageous for recipient defects located in the posterior parts of the body, since the patient is ideally placed in the prone position for the harvest of the scapular flap. This is also a disadvantage in reconstructing anteriorly located recipient sites, where patient repositioning will be necessary for scapular flap harvest. Thus in such situations, it appears logical, if possible, to choose other cutaneous flaps from the anterior body surface or the extremities. The vertically oriented scapular flap can also be raised with the patient in a lateral decubitus position. Preoperative Doppler examination of the triangular space will prove useful in locating the branches of the circumflex scapular vessels.

Neurovascular Anatomy

The harvestable cutaneous territory of the transverse scapular flap (≈20 cm × 10 cm) is located between the angle and spine of the scapula, whereas the obliquely oriented parascapular flap (25 cm × 10 cm) is outlined, centered over the lateral border of the scapula. Both these territories are nourished by the two respective branches of the circumflex scapular artery that emerges to the suprafascial surface from the triangular space, bordered laterally by the long head of triceps and inferiorly by the teres major muscle belly and superiorly by the teres minor muscle (Fig. 18.1).

The triangular space should be included in the either of the above-mentioned flap geometries. The circumflex scapular artery may be traced to the subscapular artery, which in its turn arises from the third part of the axillary artery, lateral to the border of the subscapularis muscle. As the circumflex scapular artery curves around the lateral border of the scapula to “surface” through the triangular space, it gives off tiny branches to the teres major, teres minor, and infraspinatus muscles, as well as to the periosteal vessels of the scapular border, based on which a strip of bone may be raised with the flap. After emerging from the triangular space, the circumflex scapular artery takes a short caudal course (ca. 2–3 cm), after which it bifurcates into the transverse and vertical branches. Venous drainage of the flaps is through venae comitantes that accompany the arterial branches. Cutaneous nerves do not accompany the vessels. Sensory innervation of the flaps is achieved by segmental branches that run from medial to lateral and is usually
Fig. 18.1  The vascular anatomical basis of the scapular and parascapular flaps.

Fig. 18.2  Planning markings of the scapular and parascapular flaps.