Muscle Transposition Flaps for Coverage of Lower Extremity Defects

Anatomic Considerations

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Full thickness skin loss in the lower extremity presents special difficulties to the surgeon and his patient. Soft tissue in juxtaposition to the wound is usually remarkably thin and poorly vascularized. Moreover, the base of the wound very often is exposed, dead, infected bone. These chronic, persistent, economically debilitating ulcerations, traumatic, vascular, metabolic, or infectious in origin, classically are managed by split thickness skin grafts or distant flaps. In 1966, Ralph Ger suggested the use of muscle as a transposed flap as a practical single stage technique to accomplish coverage for these difficult ulcerative lesions.

The principle of muscle transposition to provide cover for areas of tissue loss in the lower extremity is now well established. Critical to successful, safe, effective transfer of such a muscle flap is a precise working knowledge of the anatomy of the muscle under consideration. A number of criteria based on muscle anatomy and function have been defined to evaluate the potential of a muscle for its use as a transposition flap.

To be suitable for transposition a muscle must have a belly of reasonable size. One determinant of the extent of rotation is muscle length. The site of the principal arterial source and venous return equally influence the feasibility of the use of a particular muscle as a flap. If the vascular pedicle is located close to the origin, the muscle can then be extensively rotated with safety. In cases of multiple arterial muscular branches, the branches in the proximal third of the muscle must be dominant or the muscle will not survive as an immediate transposition flap. Under these circumstances a delay procedure would be prudent.

A lower extremity muscle used in transfer can obviously no longer serve its original locomotor function. Consequently, there should be an ample number of synergistic muscles to compensate for this deletion of muscular function. Preservation of motor innervation is not an absolute requirement in the muscle flap since muscular contractions in the rotated position serve no function. In fact, in some circumstances the eventual decrease of denervated muscle bulk well may be a desirable feature.

Brash's anatomical study of the lower extremity offers excellent data on the site of motor nerve entry into the muscles of the lower extremity. Data concerning the site and variability of the arterial supply of the lower extremity muscles have not been as well documented. While exploring the possibilities of muscles for use in transfer procedures, therefore, we found it necessary to perform detailed vascular dissections on amputated limbs. Dissections on ten such above knee amputations with the vasculature injected with colored latex for precise identification and localization of arterial muscle blood supply has provided these data. Results of this anatomic study on muscles in the lower extremity which have potential for use as a muscle flap are presented.
**Gastrocnemius**

The gastrocnemius is a superficial posterior leg muscle composed of medial and lateral bellies that merge midway in the leg to form a common tendon. The longer medial belly may be utilized to cover defects in the proximal third of the tibia. The muscle can be exposed by a midposterior incision. Our dissections disclosed that each belly receives a single large artery derived from the popliteal artery. These branches penetrate the muscle above the level of the tibial epicondyles. Loss of the gastrocnemius is easily compensated for, since plantar flexion can be performed by the soleus, flexor digitorum longus, flexor hallucis longus, tibialis posterior, and plantaris muscles.

**Soleus**

This superficial posterior muscle has a broad muscle belly admirably suited for transfer procedures. It lies anterior to the gastrocnemius and is best exposed through a posteromedial incision. It inserts as part of the Achilles tendon and must be sharply separated at this level for use in transfer procedures. If transposed, it can cover defects in the middle third of the leg. In our dissections, the dominant arterial vessels to the muscle were branches from the peroneal artery and a large proximal branch from the posterior tibial artery. There were two or three more inferior branches derived from the posterior tibial artery. The more proximal branches were consistently present, allowing safe transfer. The most distal branch can be sacrificed and the muscle transposed safely on the more proximal vascular pedicle. Following transfer, the plantar flexion of this muscle would be preserved by the other strong plantar flexors mentioned above. Except in rare circumstances, the soleus and gastrocnemius have not been utilized in the same lower extremity since plantar flexion would be seriously impaired in such cases.

**Flexor Digitorum Longus**

The flexor digitorum longus is a deep posterior leg muscle with a moderate size belly. Since this muscle is immediately posterior and adjacent to the soleus muscle, it is best used for supplementary coverage with the soleus muscle to correct defects in the middle third of the leg. In our dissections there were constant arterial branches entering the proximal third from the posterior tibial artery. However, there was also a distal third arterial branch derived from the posterior tibial artery. Sacrifice of this distal branch in transfer might be critical in certain cases. The function of phalangeal flexion would be preserved by the flexor digitorum brevis.

**Peroneus Longus**

The peroneus longus is a lateral leg muscle with a belly suitable in size for transfer for coverage of defects in the lateral middle or distal third of the leg. Exposure may be gained through a posterior lateral incision. The source of arterial blood supply to this muscle is the peroneal artery. One or two arterial branches enter the more proximal portion of the muscle mass. Plantar flexion and foot eversion would persist with deletion of this muscle function provided the foot flexors and the peroneus brevis muscle remained intact.
Peroneus Brevis

A second lateral leg muscle is the peroneus brevis. Its smaller belly is located inferior and adjacent to the peroneus longus. It represents a muscle for use with the peroneus longus for coverage of large defects in the lateral inferior third of the leg. In our dissections, the arterial supply was consistently a branch from the peroneal artery entering the proximal portion of the muscle. When used along with the peroneus longus muscle in transfer, the foot would lose eversion. Such a loss in most circumstances would generally be an acceptable disability.

Abductor Hallucis

The abductor hallucis muscle is a medial posterior intrinsic muscle of the foot. It has an adequate muscle belly for coverage of defects in the area of the medial malleolus. The muscle can be reached by a medial transverse incision in the foot. In our dissections, the arterial source originates from branches of the medial plantar artery. Consistently there was a large proximal branch. Variably, two to three smaller branches entered along the muscle belly. With transfer of this muscle, its function of great toe abduction and foot spring would be lost.

Abductor Digiti Minimi

This muscle is a lateral posterior intrinsic muscle of the foot. This muscle mass may be transposed to provide coverage of defects about the lateral malleolus. Access to the muscle is easily accomplished through a lateral horizontal incision in the foot. In our dissections, the arterial supply for this muscle is consistently from one branch derived from the lateral plantar artery. This branch enters close to the origin of the muscle belly. Some loss of abduction and flexion of the fifth toe would be expected following this muscle's transfer.

Flexor Digitorum Brevis

The flexor digitorum brevis muscle is a posterior intrinsic muscle of the foot. It has a muscle belly which, when folded posteriorly, can provide coverage of defects overlying the calcaneus and heel. The muscle is exposed through a midplantar incision. In our dissections, the muscle has dual blood supply from an arterial branch of the medial plantar artery along the midbelly and from an arterial branch from the lateral plantar artery proximal near its origin. This second source of arterial supply appears constantly and should be adequate to preserve the muscle circulation with transfer. Following transfer of this muscle, lateral phalangeal flexion would be preserved by the action of the flexor digitorum longus.

Summary

The latex injection technique, even in extremities amputated for vascular disease, can provide anatomic specimens that yield information about the precise localization of arterial supply to muscles. Dissections in such specimens have provided the necessary surgical anatomic knowledge for safe, effective, one-stage muscle transposition procedures. The vascular anatomy of muscles suitable for transposition flaps in the leg and foot has been
described to aid the surgeon whose practice includes the care of patients with skin and soft tissue losses.