DIFFERENT MODALITIES IN RECONSTRUCTION OF SOFT TISSUE DEFECTS OF THE FOOT

Essay

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By

Ahmed Mostafa H. El Shazly
(M.B.B.Ch)

Supervised by

Prof. Dr. Mohamed Alaa El Din Gheita

Professor of General and Plastic Surgery

Faculty of Medicine, Cairo University

Prof. Dr. Aly Moftah Aziz Moftah

Professor of General and Plastic Surgery

Faculty of Medicine, Cairo University

Dr. Khoweiled Abd El Halim Khoweiled

Lecturer of General Surgery

Faculty of Medicine, Cairo University

Faculty of Medicine
Cairo University
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بسم الله الرحمن الرحيم

﴿قالوا سبحانك لا علم لنا إلا ما علمتنا
إنك أنت العليم الحكيم﴾

صدق الله العظيم

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ABBREVIATIONS

FD	:	Foot defect.
WB	:	Weight bearing.
NWB	:	Non weight bearing.
ST	:	Soft tissue.
BT	:	Bone tissue.
(C\D\P)	:	Calcaneus, dorsal, plantar.

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INTRODUCTION

Soft tissue coverage of the foot continues to emerge as a viable alternative for treating chronic wounds, a variety of techniques, ranging from skin grafts to pedicle flaps, which can be used to close longstanding, recalcitrant wounds in the foot and ankle **(Zgonis et al, 2003).**

The soft tissue envelope of the foot resists severe mechanical stresses on a daily basis and protects the underlying structures from injury. However, an injury to the foot or a chronic ulcer can cause a defect in the soft tissues and presents a challenge for the foot and ankle specialist. When the defect is on the sole of the foot, the injury may be disastrous **(Jolly et al., 2003).**

Historically, soft tissue lesions have been treated conservatively via various techniques of offloading, local wound care, molded shoes, inserts and orthoses. While some wounds lend themselves well to non-operative treatment, there are many wounds that either refuse to close or close with a resultant scar that is so unstable that recurrence of the ulcer is all but assured **(Jolly et al., 2003).**

Since the 1980, there has been an emerging body of literature reporting on outcomes from reconstruction of the soft tissue defects of the foot. Historically these procedures were the domain of the plastic surgeon. The ability of a surgeon to close a wound which has been opened for months and sometimes years, gives new hope to many patients and their families, whose lives revolve around the long-term treatment of these wounds **(Jolly et al, 2003).**

Soft tissue reconstruction of the foot and ankle includes the use of skin grafts, local flaps and pedicle flaps. The use of free flaps, once essential in the treatment of defects of the hind foot and ankle, has waned with the advent of reverse flow neurocutaneous flaps harvested from the lower leg **(Zgonis et al., 2003).**

AIM OF THE WORK

To shed light on different reconstructive modalities of the soft tissue defects of the foot starting from simple closure of the wound to the more sophisticated microvascular free tissue transfer and to suggest a therapeutic approach in those some time difficult cases. Some clinical cases will be presented.

ANATOMY OF THE FOOT

The foot is the part of the lower limb starting from the ankle and ending by the toes. It is formed of a bony skeleton, fascia, muscles, vessels, and nerves all covered by subcutaneous tissue and skin **(Last, 1990).**

The skin on the dorsum of the foot is thin and mobile, and there is relatively little subcutaneous fat. However, the skin of the heel pad consists of a very thick epidermis that is firmly anchored to the plantar aponeurosis by a complex of fibrous septa running perpendicularly. Immediately beneath the dermis lie the superficial and the deeper subcutaneous layers. These two layers are separated by a thick horizontal septum composed of bundles of fibers. The deep subcutaneous layer contains thick septa, the plantar aponeurosis, and is attached to the periosteum of the calcaneus. Interspersed between the septa are semisolid loculi of fat that absorb and disperse the pressures of weight bearing. Through these loculi runs a profusion of sensory propreoceptive nerves innervating the skin of the heel **(Cormak and Lamberty, 1986).**

A. Fascia of the sole of the foot:

Superficial fascia:

Along the lateral border of the foot, at the ball of the foot, and, at the heel, it is thick, tough and granular. It is traversed by tough, fibrous bands which, connect the skin with the deep fascia, and subdivide the fatty tissue into small tight lobules making it firm and resilient. Near the webs of the toes, and superficial to the digital vessels and nerves there is a weak band of fibers called the superficial transverse metatarsal ligament **(Romans, 1975).**

Deep fascia:

Deep fascia on the toes: on each toe the deep fascia is thickened to form a curved plate, the fibrous flexor sheath, which is attached to the margins of the first and second phalanges (only the first in the big toe) and to the margins of the plantar ligaments of the joints. It forms with them a tunnel, which holds the long and short flexor tendons. Distally, the fibrous flexor sheath is attached to the base of the terminal phalanx beyond the insertion of the long flexor tendon. Proximally it is continuous with the slips of the plantar aponeurosis, it is thick and strong opposite the phalanges but thin and weak opposite the joints so that it does not hamper their movements.

The deep fascia of the sole is termed deep fascial proper, is divided into 3 parts:

a. Medial

b. Intermediate

c. Lateral

The division is indicated by a difference in the density of the three parts and by two shallow furrows, which traverse the foot in a longitudinal direction each of the three portions, is related to a muscle, which takes part of its origin from it **(Cormak and Lamberty, 1986).**

Plantar aponeurosis:

The intermediate part covers the flexor digitorum brevis. It stands out in marked contrast to the lateral and medial parts in points of strength and density and is called the plantar aponeurosis. Its posterior end is narrow and is attached to the medial process of the calcanean tuberousity. It expands as it passes forwards and, near the heads of the metatarsal bones, it splits into fine processes, which proceed towards toes and bound together by transverse fibers. In the interval between each two of these digital processes lie a plantar metatarsal artery, a plantar digital nerve, and a lumbrical muscle. An intermuscular septum springs from each

margin of the plantar aponeurosis into the sole on each side of the flexor digitorum brevis and separates it from the abductor hallucis and abductor digiti minimi (**Snell, 1995).**

B. Bones of the foot:

The bony skeleton of the foot has three segments the Tarsus, the Metatarsus and the Phalanges **(Cormak and Lamberty, 1986).**

1. The Tarsus:

The seven bones of the tarsus make up the skeleton of the posterior half of the foot **(Warwick and Williams, 1992).** The tarsus is formed of:

a. The Talus:

The talus is the connecting link between the bones of the leg and the rest of the foot.

b. The Calcaneus:

It is the largest of the tarsal bones; it projects backwards beyond the bones of the leg so as to provide a useful lever for the muscles of the calf.

c. The Navicular bone:

It is interposed between the head of the talus proximally and the cuneiform bones distally.

d. The Cuneiform bones:

The three cuneiform bones are wedge shaped and articulate with the Navicular bone proximally and the basis of the first, second and third metatarsal bones distally. The arrangement of these bones is an important factor in the construction of the transverse arch of the foot.

e. The Cuboid Bone:

The cuboid bone is the most lateral of the distal row of the tarsus, and is situated between the calcaneus proximally and the fourth and fifth metatarsal distally.

2. The Metatarsus:

The metatarsus consists of five metatarsus bones situated in the distal part of the foot, connecting the tarsus to the phalanges**.**

3. The Phalanges:

The phalanges of the foot correspond in number and general arrangement with those of the hand, there are two in the big toe and three in each of the other toes.

C. Muscles of the Foot:

The muscles of the foot are either intrinsic (confined to the foot) or extrinsic (related to the leg). The intrinsic muscles of the foot are divided into dorsal and plantar groups: **(Cormak and Lamberty, 1986).**

1. The Dorsal Muscles of the Foot:

The extensor digitorum brevis is the only intrinsic muscle on the dorsum of the foot and is sometimes termed the extensor hallucis brevis.

2. The Plantar Muscles of the Foot:

The plantar muscles of the foot are placed in four groups or layers, which are:

a. The first layer:

This is the superficial layer, includes the abductor hallucis, abductor digiti minimi and the flexor digitorum brevis. All three extend from the calcanean tuberousity to the toes, and therefore, comprise a functional group capable of assisting in maintaining the concavity of the foot **(Warwick and Williams, 1992).**

b. The second layer:

The muscles of this group lie between those of the superficial layer. They include the flexor digitorum accessorius and four lumbrical muscles.

c. The third layer:

This group comprises the shorter intrinsic muscles of the hallux and the fifth digit, which are the flexor hallucis brevis, adductor hallucis and flexor digit minimi brevis. These are the most deeply situated muscles in the sole, except for the interossei, which are superior to them.

d. The fourth layer:

This group comprises the plantar and dorsal interossei which are similar to those in the hand, but they are arranged relative to the second and not to the third digit, the second being the least mobile of the metatarsal bones.

D. Blood supply of the foot:

Arterial supply:

The arterial supply of the foot is the normal continuation of that of the leg **(Attinger et al., 1997).**

1. The Anterior Tibial artery:

Arises from the popliteal bifurcation at the lower end of the popliteus muscle. It passes forwards above the interosseous membrane of the leg till the lower end of the tibia where it becomes the dorsalis pedis artery.

a. Arteries around the ankle joint:

They anastomose freely to form network below the corresponding malleolus.

Medial malleolar network:

Is formed by the anterior medial malleolar branch of the anterior tibial artery, the medial tarsal branch of dorsalis pedis, the malleolar and calcanean branches of the posterior tibial and branches from the medial plantar artery.

Lateral malleolar network:

Is formed by the anterior malleolar branch of the anterior tibial artery, the lateral tarsal branch of the dorsalis pedis artery, the perforating

and calcanean branches of the peroneal artery and twigs from the lateral plantar artery.

b. The dorsal artery of the foot (dorsalis pedis):

Is the extension of the anterior tibial artery distal to the ankle joint. It follows the tibial side of the dorsum of the foot to the proximal end of the first intermetatarsal space,where it turns into the sole of the foot to complete the plantar arch.

c. The tarsal arteries:

Lateral and medial, come from the dorsalis pedis as it crosses the navicular bone the branches anastomose with branches of the arcuate, anterior lateral malleolar and lateral plantar arteries. The medial branches ramify on the border of the foot and join the medial malleolar network

d. The arcuate artery:

Arises from the dorsal artery of the foot opposite the medial cuneiform; it passes laterally to anastomose with the lateral tarsal and lateral plantar arteries **(Warwick and Williams, 1992).**

2. The Posterior Tibial artery:

a. The calcanean branches:

Arise from the posterior tibial just above the division they pierce the flexor retinaculum to anastomose with the medial malleolar arteries and calcanean branches of peroneal artery.

b. The medial plantar artery:

The smaller terminal branch of the posterior tibial, passes distally along the medial side of the foot with the medial plantar nerve to reach the base of the first metatarsal bone to anastomose with a branch of the first metatarsal artery **(Warwick and Williams, 1992)**