TENDON TRANSFER IN THE FOOT

AN ESSAY

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CONTENTS

	Page
INTRODUCTION	1
ANATOMICAL AND PHYSIOLOGICAL CONSIDERATION ...	2
OBJECTIVES AND INDICATIONS	12
PRINCIPLES OF TENDON TRANSFER IN THE FOOT	24
FOOT DEFORMITIES	41
TENDON TRANSFER OPERATIONS IN THE FOOT	51
- Methods	51
- Post operative care	93
- Complications	97
SUMMARY	102
REFERENCES	106
ARABIC SUMMARY	

INTRODUCTION

Tendon transfer implies detachment of a normal and active tendon at its insertion, transposition to its new position and then reattachment to a new insertion in a bone or into another tendon so that it may afford motor assistance to a partially paralysed muscle, or motor substitution for a completely paralysed muscle.

Careful selection of cases, improved techniques, with the preservation of physiologic function and sofisticated post operative rehabilitation now make tendon transfer a viable procedure.

For a transferred muscle to function effectively, every detail of the procedure must be based on accurate knowledge of the anatomy and physiology of tendons and muscles.

PART (I)

ANATOMICAL and PHYSIOLOGICAL CONSIDERATION

ANATOMICAL AND PHYSIOLOGICAL CONSIDERATION

The Tendon :

It is a flexible fibrous tissue that offers great resistance to a pulling force. It consists of a type of dense connective tissue fashioned into fibres and arranged in an orderly (parallel) pattern. Each fibre is composed of a large number of fibrils and is surrounded by a loose areolar connective tissue called endotendineum. The peritendineum surrounds a group of fibres. These bundles of fibres are called fascicles. The whole tendon, composed of a variable number of fascicles, is enclosed in a thick connective tissue sheath, the epitendineum. Fibroblasts are found between the parallel collagenous bundles (AREY, 1963).

The Tendon Sheath :

The sheath works essentially like a piston in a cylinder, and the tendon glides on a thin film of synovial fluid. The mechanism consists of two layers of synovia : a visceral layer (epitenon) covering the tendon, and a parietal layer (sheath) lining the fascial tunnel through which the tendon glides. The tendon in a sheath passes across the concavity of the joint or around curves and bends to produce a pully mechanism, which consists of thickened parts of fascial sheaths. The sheaths and fasciae prevent the tendon from bowstrining across the joint (MAYER, 1937).

The Mesotenon :

It is a delicate connective tissue membrane connecting the tendon with the floor of the sheath which corresponds roughly to the mesentry of the intestine. This mesotenon is loose and filmy and allow the tendon to glide. It is located on the convex side of the tendon, away from friction, and contains the vascular structures for the tendon.

The mesotenon differs radically in one respect from the mesentry; it may be absent. Thus the tendon of the tibialis posterior is always without a mesotenon; 70 % of the tendons of flexor hallucis longus and 50 % of the tendons of the flexor digitorum longus are also without mesotenon. When the mesotenon is absent it is represented at each end of the sheath by a short membrane called the vinculum which may be triangular or quadrangular in shape (MAYER, 1937).

The Paratenon :

It is an elastic, pliable tissue that allows the tendon to glide. It fills the space between the tendon and the immovable fascial compartment through which the tendon moves, and it is attached at the end to the fascia or to some fixed structure (Mayer, 1937).

Blood Supply of Tendon :

According to Peacock (1959), the blood vessels of the tendon are derived from three main sources :

1) From muscular branches.
2) From vessels running in the surrounding connective tissue paratenon, mesotenon and vincula.
3) From vessels of the bone and periosteum near the point of insertion of the tendon.

The mesotenon or vinculum, a delicate connective tissue membrane that connect the tendon with the floor of the sheath, transmits blood vessels to the tendon. These vessels do not penetrate the tendon fibres directly but allow blood borne cells that have the potential to synthesize fibrous tissue to migrate to tendon areas that require repair and/or nutrition.

This concept of exogenous vascularization is significant in any attempt to avoid post transfer adhesions, because distrupting the mesotenon or vinculum of the transferred tendon will not in itself result in adhesions. However, unless rigid haemostasis is practiced, haemorrhage can occur between tendon and paratenon and tendon sheath, which allow for fibrous proliferation and resultant adhesions.

Similary if a tendon is damaged along its longitudenal surface by rough handling or a partial laceration, the interior of the tendon is exposed and scar tissue often exerts a severe restricting influence.

The blood vessels entering long tendon from the muscular origin and periosteal insertion are able to nourish the proximal and distal third of the tendon while the middle third can not be nourished by anastomosis with vessels entering from either end but by intermediate segmental vessels entering through disorganized paratenon or a definite volar mesentry.

In free grafts this portion of the circulation is restored through post operative adhesions so with the knowledge that tendon adhesions appear to carry vessels of vital importance, complete prevention of adhesions by mechanical barrier

PART (II)

OBJECTIVES and INDICATIONS OF TENDON TRANSFER IN THE FOOT

resulted in death of the cells in the center of the tendon and eventual disintegration of collagen bundles.

The Mechanism of Gliding of Tendon :

The tendon sheath is not responsible for the tendon's ability to glide because it lacks elasticity.

The gliding mechanism depends exclusively on the paratenon an elastic connective tissue covering. Paratenon elasticity enables it to stretch several centimeters. The entire tendon is covered by the paratenon, which is firmly attached and doubled over at both ends of the tendon.

Where the tendon sheath is absent, the tendon and overlying paratenon are enveloped in fatty areolar tissue.

It is imperative to preserve this elastic structure to ensure proper gliding of the transferred tendon. When the paratenon is stripped or damaged in the transfer procedure the tendon develops postoperative adhesions that seriously interfere with normal physiologic gliding (ARENSON, et al. 1976).

MUSCLE FUNCTION IN THE FOOT :

According to Mann (1982), when evaluating a patient for muscle weakness or loss about the foot and ankle, it is helpful to draw a diagram of the axes of the ankle and subtalar joint in the clinical chart and note the strengths of each muscle in relation to the axes.

By this method it is possible to carefully note which muscles are functioning and thereby make it possible to accurately plan the muscle transfer.

The relationship of the muscles to the subtalar and ankle joint axes is presented in (Fig. 1).

The muscles which lie posterior to the ankle joint axis produce plantar flexion, while those anterior to it produce dorsiflexion.

The muscles lying medial to the subtalar joint axis are invertors and those lateral to it are evertors.

When the axes of the ankle and the subtalar joints are considered together a muscle that is posterior and medial to the axes is a plantar flexor and invertor e.g. tibialis posterior, and one that is anterior and lateral to them is

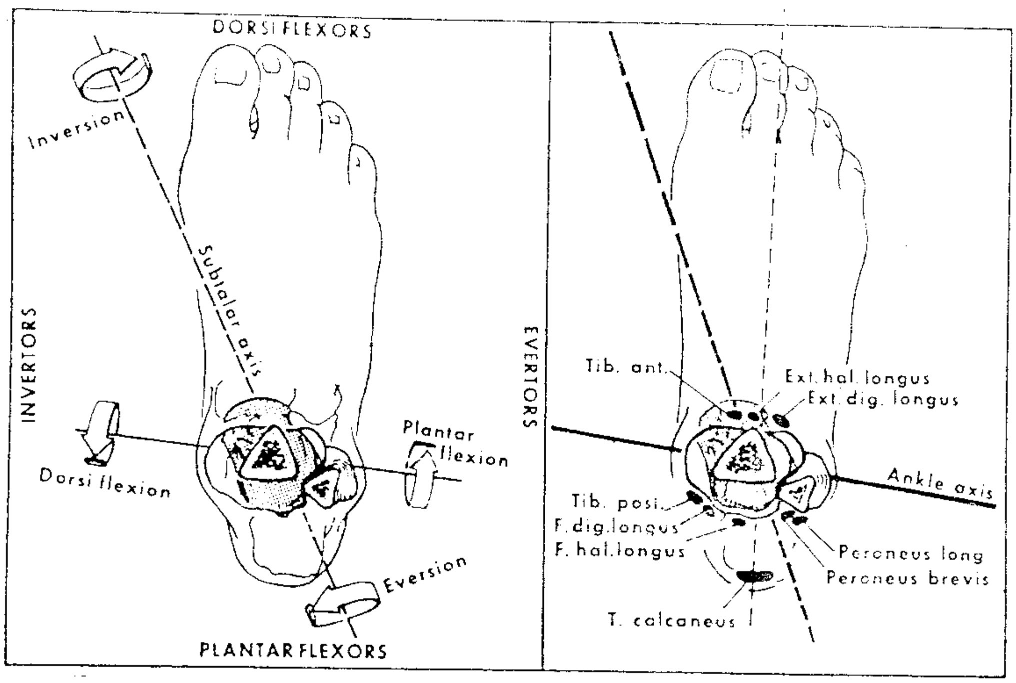

Figure 1 The diagram on the left demonstrates the relation that occurs about the subtalar and ankle joint axes. The drawing on the right demonstrates the relationship of the various muscles about the subtalar and ankle joint axes. (From Mann, R. A.: Biomechanics of the foot. In American Academy of Orthopaedic Surgeons: Atlas of Orthotics. St. Louis, The C. V. Mosby Co., 1975.)

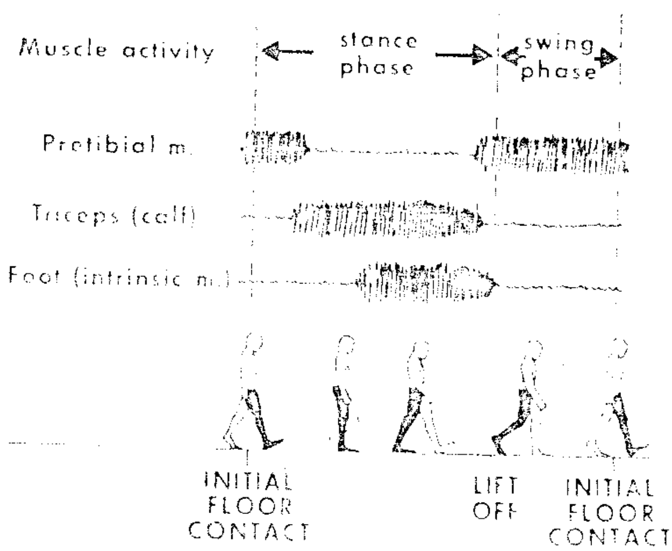

Figure 2 [illegible]

a dorsiflexor and evertor e.g. extensor digitorum longus.

By keeping this relationship in mind, it is possible to readily diagnose when a certain type of deformity is present owing to paralysis of a specific muscle group, as well as which muscles may be transferred to correct the imbalance.

A. The Muscles of The Anterior Compartment of The Calf :

Namely the tibialis anterior, extensor digitorum longus, extensor hallucis longus and peroneus tertius, they work as a functional group (Fig. 2). These muscles are functioning intially to bring about dorsiflexion of the ankle joint during the swing phase and following initial floor contact, permit controlled plantar flexion of the ankle joint.

Loss of function of these anterior calf muscles results in a foot slap at the time of initial floor contact and a steppage type of gait that is manifested by increased knee flexion during the swing phase.

B. The Posterior Calf Musculature :

Consists of the gastrocnemius, soleus, tibialis posterior, flexor hallucis longus, and flexor digitorum