ANKLE ARTHROPLASTY

ESSAY

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By

Ramez Halim Nessim

M.B.B.ch.

Under the Supervision of

Prof. Dr. Osama M. Abd El Halim Shata

Professor of Orthopaedic Surgery

Faculty of Medicine - Ain Shams University

And

Dr. Abd El Mohsen Arafa Ali

Lecture of Orthopaedic Surgery

Faculty of Medicine - Ain Shams University

Faculty of Medicine

Ain Shams University

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INTRODUCTION

The major disabling complaints of any joint are pain and loss of normal mobility of this joints which may be due to advanced disease or trauma . --

The surgeons overlap this problem with great successful results in the hip and knee by arthroplasty of these joints .

Because painless & normally mobile joint is essential for normal .ndividual life this encourages the surgeons to proceed into ankle ar- :hroplasty . But ankle arthroplasty was relatively delayed , because :he permanent disability of the ankle is somewhat less common than ɔther joints , also informations available about the biomechanics of he ankle were less .

Arthrodesis was the treatment of choice in disabling ankle , but it s not usually successfull , also ankle motion is lost . The disadvan- ages of arthrodesis & marked success of arthroplasty of other joints :ncouraged that of ankle .

\fter further experience and longer periods of observation, reviews most series of ankle arthroplasty revealed poor long-term results , ecially in younger patients with traumatic arthritis ,current ankle ıroplasty have quite limited use . However , new implant designs and the use of noncemented biologic fixation may solve many of the current problems and provide a dependable and highly success full alternative to arthrodesis . (Tooms 1987) .

BIOMECHANICS OF THE ANKLE JOINT

PATTERN OF ANKLE JOINT MOVEMENTS IN RELATION TO THE GAIT CYCLE : Fig. (1)

A. THE STANCE PHASE

Is the period during which the body weight is being born by the extremity , it begins when the heal touches the ground (heel-strike) .where the ankle is in slight plantar flex ion which gradually decreases till the foot flats on the ground (foot flat) .

As the body weight moves forward over the fixed foot, it comes directly over the ankle joint (mid-stance) & dorsiflexion starts .

With continuous forward progression of the body, the heel leaves the ground (heel-off) & the foot looses all contact with the floor (toe-off), the limb then enters the swing phase .

By the end of stance phase after heel off , plantar flexion occurs

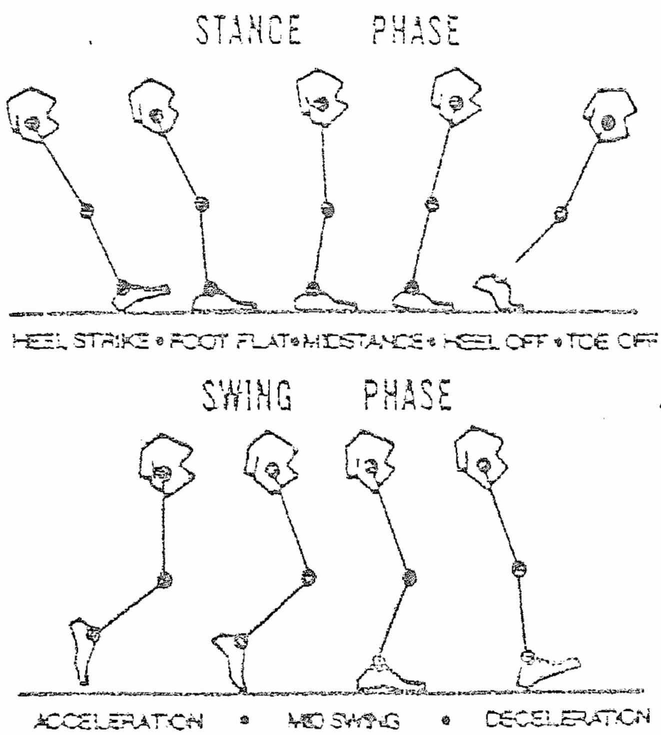

Fig. (1)
PHASES OF THE GAIT CYCLE
(Stauffer, R.N., 1977) .

again .

B. THE SWING PHASE

The portion of the gait cycle during which a limb is being advanced forward without ground contact , during which forward momentum is transported to the extremity by the hip flexors is termed the period of accleration . Once the limb has been accelerated , it passes over the ground in midswring by its inertia. The forward-swinging extremity is then slowed in space by the activity of the hamstrings during the period of deceleration . During the stance & swing phase the ankle is normally in dorsiflexion .

The 2 phases constitute a single gait cycle . During normal walking speeds , stance phase occupies about 60% of the cycle & swing phase is 40% of the cycle .

THE AXIS OF ANKLE MOVEMENTS :-

The axis of ankle movement is not horizontal. Inman & Isman 1968 reported that the axis of rotation of the ankle joint runs just below the tips of the maleoli. It is directed lateraly & posteriorly .

This axis changes during ankle movements, inclining infero-medially on plantar flexion & infero-laterally on dorsiflexion (Barnet & Napier, 1952)

FORCES ACTING ON THE ANKLE JOINT

The forces are :

I Compressive or loading forces

II Tangential or shearing forces

III Tendon forces

I COMPRESSIVE (LOADING) FORCES

Both imagnitude and distribution of these forces should be analysed

A. MAGNITUDE OF THESE FORCES :-

Under static conditions, these forces equal body weight on standing on the whole sole & equal twice body weight on standing on heel & equal 3 times body weight on standing on toe tips (Weber.1977)

During walking, these forces vary. at heel strike, it is the resultant of vertical loading force & horizontal shearing force .

This gradually increases till reaches 3 times body weight when foot flats . Then remains constant till heel-off . When heel is off it reaches 4.5 - 5.5 body weight. While at toe-off it is the resultant of vertical loading and horizontal shearing forces, (Stauffer et al, 1977)

b. DISTRIBUTION OF THESE FORCES :-

Under static conditions, these forces act on the inner aspect of the maleoli & marginal zones of the talar dome on partial weight bearing . This increase to include 2/3 of the upper surface of trochlea on full weight bearing (Greenwald et al 1977) . During stance phase the forces are evenly distributed across the joint .

II TANGENTIAL (SHEAR) FORCES :-

A tangential force across the ankle is created as a result of a combination of :-

a- Internal tendon forces .

b- External forces of the body moving over the foot .

During all gait phases a valgus-inducing torsional momentum exerts an action around the sagittal longitudinal axis of the foot . This torque is counteracted by the tendency to varus rotation by the supinating muscle forces & the lateral support supplied by the lateral maleolus & the syndesmotic ligaments . Thus the syndesmotic ligaments & the lateral maleolus are of paramount importance in maintaining congruity during normal weight bearing (Stauffer et al , 1977)

III TENDON FORCES

Tendons acting across the ankle joint generate dynamic & passive tensile forces to provide stability , angular acceleration & deceleration . The force exerted by the achillis tendon as a plantar flexor & that exerted by the tibialis anterior as a dorsiflexor are much greater than that of other plantar or dorsiflexors , even when combined . This is because they have a larger muscle mass & larger lever arm . Other plantar or dorsi-flexors have either shorter lever arm or inserted further distal to the ankle joint . (Samuelson , 1984) .

STABILITY OF THE ANKLE JOINT

The factors contributing to the stability of the ankle joint are :-

I Bony factors

II- Ligamentous factors .

III- Muscular factors .

I - BONY FACTORS :

The two maleoli act as 2 stabilizing surfaces for side to side movements of the talus . In addition to the lateral stabilizing effect of the plantar flexors on the lateral maleolus on standing on toes tips when the pincer tightens & the fibula migates distally & pulled medially .

Bony stability is also provided by the shape of the talus dome & how it mates with the distal tibial articular surface . Also the difference between the anterior & posterior talar trochlea corresponds to the difference in the intermaleolar distance , both being wider anteriorly . The maleoli closely approximate the sides of the talus in all positions throughout the normal range of motion .

The posterior tibial margin projects further distally than the anterior.This posterior tibial socket is further deepened by the fibres of the inferior transverse tibio-fibular ligament (Close,1956Inman1946)

II - LIGAMENTOUS FACTORS

A. THE MEDIAL COLLATERAL LIGAMENT (FIG .2)

I - THE SUPERFICIAL SET OF FIBRES

a - The anterior group (tibio - navicular) :

b. The middle group (tibio - calcaneal)

c. The posterior group (posterior tibio - talar)

2- THE DEEP SET OF FIBRES (ANTERIOR TIBIO - TALAR)

B. THE LATERAL COLLATERAL LIGAMENT (Fig 3)

1. THE ANTERIOR TALO-FIBULAR LIGAMENT :

2- THE CALCANEO-FIBULAR LIGAMENT

3- THE POSTERIOR TALO-FIBULAR LIGAMENT :

III MUSCULAR FACTORS :

In the symmetrical erect posture , the line of the body weight falls in front of the ankle joint. Stabilization of this posture requires persistant activity of the soleus muscle , & often intermittent activity of gastrocnaemius muscle . However , the force of contraction of these muscle undoubtely fluctuates, increasing with forward swaying & decreasing with backward swaying , (Warwick & Williams , 1973)

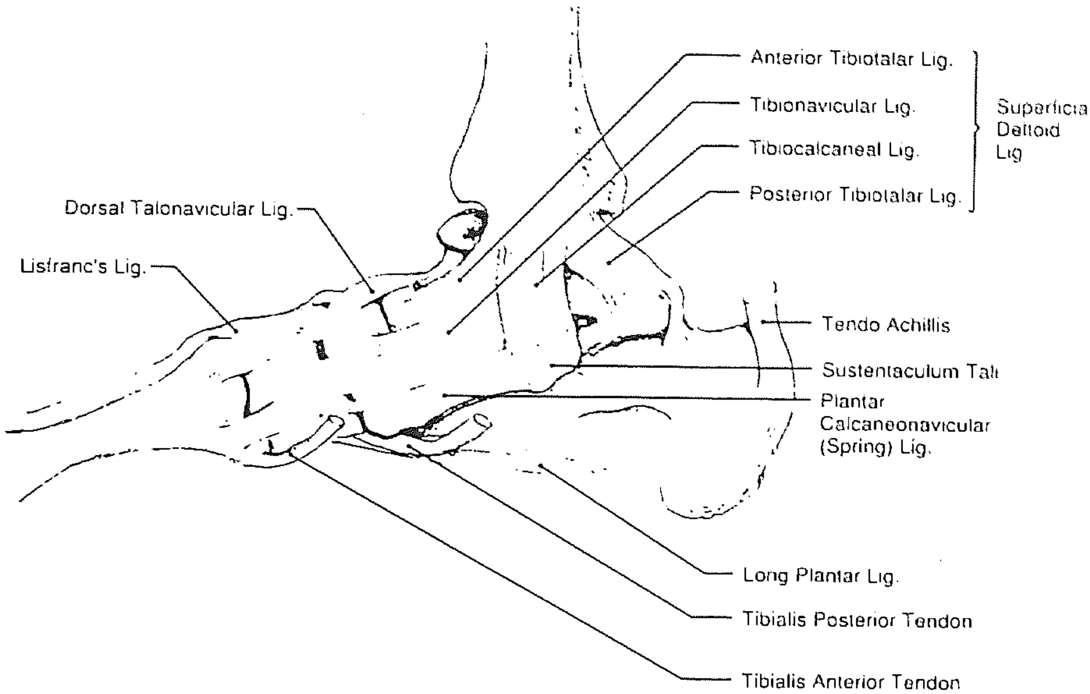

Fig. (2)
Ligaments of the ankle and foot (medial view)
(Rekling, 1990)

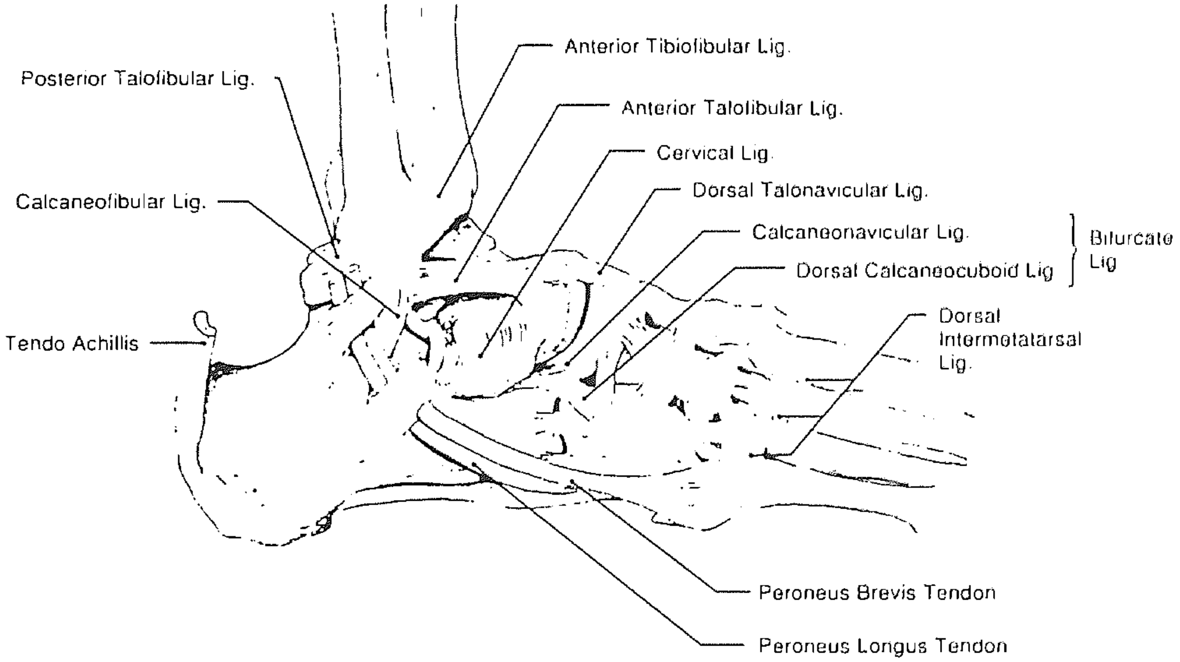

Fig. (3)
Ligaments of the ankle and foot (lateral view)
(Rekling, 1990)