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A Review of Chronic Lateral Ankle Instability

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A REVIEW OF CHRONIC LATERAL ANKLE INSTABILITY

by

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This Independent Study, submitted by Marcy K. Narum in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

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ABSTRACT

Ankle injuries constitute one of the most common and most frequent injuries affecting the lower extremities, with lateral ligament sprains comprising the majority of the ankle injuries. The development of chronic lateral ankle instability is a relatively common occurrence following an acute ankle sprain. Previously the treatment of chronic lateral ankle instability has been primary surgical intervention, but more recently the initial treatment is shifting toward a conservative approach emphasizing functional rehabilitation of the unstable ankle. Frequently the treatment of recurrent sprains and chronic instability addresses only the symptoms; however, a treatment program addressing the underlying causes of instability needs to be implemented in order to restore normal stability to the ankle.

The purpose of this literature review is to examine the normal anatomy and biomechanics of the ankle joint, describe the difference between mechanical and functional instability, and discuss the etiology of chronic lateral ankle instability. Furthermore, a conservative management approach consisting of a functional rehabilitation program is outlined to provide general guidelines for the conservative treatment of chronic instability.

INTRODUCTION

Injury to the ligaments of the ankle is one of the most common injuries affecting the lower extremities, comprising between 25% and 50% of all sports-related injuries.[1] Of all ligament injuries to the ankle, 85% are lesions of the lateral ligament complex.[2] The mechanism of injury to the lateral ligaments is the inversion sprain, which frequently occurs in running and jumping sports, such as basketball, volleyball, and soccer. Ankle sprains are commonly classified according to a grading scale in which a grade I sprain constitutes a lesion of the anterior talofibular ligament (ATFL), grade II involves lesion of the ATFL and the calcaneofibular ligament (CFL), and a grade III sprain is a lesion of the ATFL, the CFL, and the posterior talofibular ligament (PTFL). According to Brostrum,[3] 66% of acute ligament injuries are isolated ruptures of the ATFL and 20% are ruptures of both the ATFL and the CFL. Ruptures to the PTFL are extremely rare.

Management of an acute ligament injury involves a wide variety of treatment methods ranging from cast immobilization to conservative functional treatment consisting of ice, compression, elevation, and limited weight bearing. Acute ankle sprains are very rarely treated surgically. Following the initial treatment, a rehabilitation program is ideally initiated to restore normal strength and proprioception to the ankle joint in order to reduce the risk of recurrent sprains and the development of chronic instability. The failure to comply with a proper rehabilitation program following an acute ankle sprain may predispose a person to chronic lateral ankle instability.

As many as 10% to 30% of patients suffering acute lateral ligament injuries will develop chronic lateral ankle instability.[4] Two types of chronic instability have been defined in the literature: mechanical and functional.[1,5,6,7] Mechanical instability is used to describe an objective measurement of ankle motion exceeding the physiological range of motion and is most often assessed clinically or radiographically; whereas functional instability is the patient's subjective description of the ankle repeatedly giving way.[1] There has been controversy in the literature regarding the correlation between mechanical and functional instability.[8,9,10,11,12,13,14]

The etiology of chronic lateral ankle instability is complex and the exact cause is still unknown. Five primary factors have been proposed to lead to chronic instability following a primary sprain, including rupture and elongation of ligaments,[10,15,16] proprioceptive deficits,[8,9,13,14,17,18] peroneal muscle weakness,[8,16,19] subtalar instability,[20,21,22] and chronic tibiofibular sprains,[16,19,21] as well as several other possible predisposing factors. Extrinsic predisposing factors may also be involved in the development of chronic instability, including poor footwear, inadequate or inappropriate rehabilitation of acute injuries, inadequate external support, and premature return to full activity levels.[23]

There appears to be a current shift in the primary treatment of chronic lateral ankle instability from surgical management to a conservative approach utilizing functional rehabilitation. According to Karlsson et al,[15] approximately 50% of patients with functional instability will successfully regain stability with a conservative approach. The functional rehabilitation approach incorporates Achilles tendon stretching, peroneal muscle strengthening, neuromuscular proprioceptive retraining, and the use of an external ankle orthotic device into the conservative management of chronic lateral ankle instability. Surgical intervention may be necessary in patients that demonstrate significant mechanical instability and in those patients for whom conservative treatment has failed.

The purpose of this paper is to examine the normal anatomy and biomechanics of the ankle joint, describe the difference between mechanical and functional instability, and discuss the etiology of chronic lateral ankle instability. Furthermore, a conservative management approach consisting of a functional rehabilitation program primarily addressing Achilles tendon stretching, peroneal muscle strengthening, proprioceptive retraining, and external ankle bracing will be outlined, and the benefits of a primary conservative treatment approach will be addressed.

ANATOMY AND BIOMECHANICS

Talocrural Joint

Joint Structure

The ankle, or talocrural joint, is a ginglymus joint consisting of the articulation between the talus, the distal tibia, and the tibial and fibular malleoli. The proximal articular surface is formed by the latter three components and is referred to as the ankle mortise.[24,25,26] The tibial or medial malleolus covers the proximal one third of the body of the talus while the fibular or lateral malleolus covers the entire lateral talus. The integrity of this mortise is maintained primarily by the medial and lateral ligament complexes, the joint capsule, and the interosseous membrane.[25,27] The body of the talus fits into the ankle mortise and supports the tibia. Within this mortise the talus essentially functions as a hinge joint.[25]

The distal articulating surface of the ankle joint consists of three articular facets on the body of the talus.[26] The medial and lateral facets articulate with the two malleoli; whereas the saddle-shaped superior trochlear facet articulates with the tibia. The talocrural joint is completely surrounded by a fibrous joint capsule that is attached above to the tibia and fibula and below to the talus.[28] Some sources describe the superior surface or trochlea of the talus as wedge shaped, being wider anteriorly than posteriorly[24,27,28] (See figure 1). During

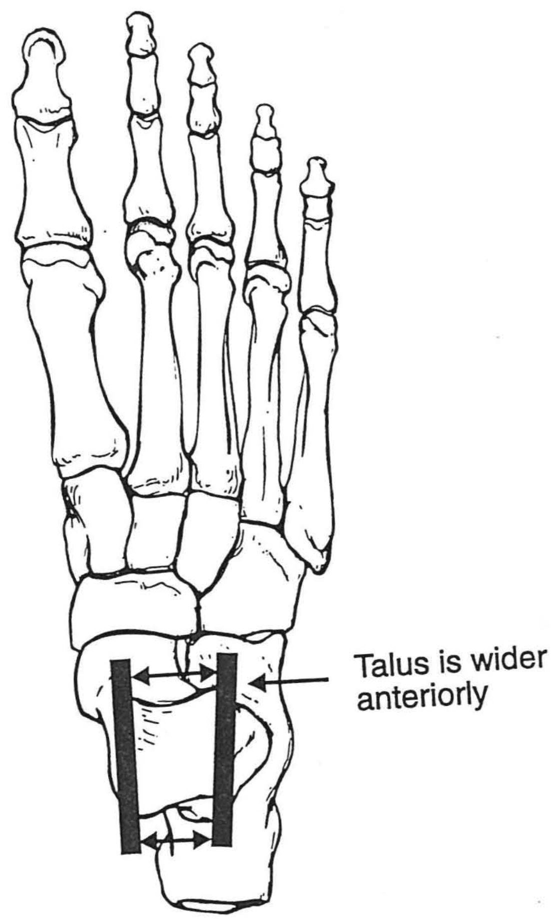
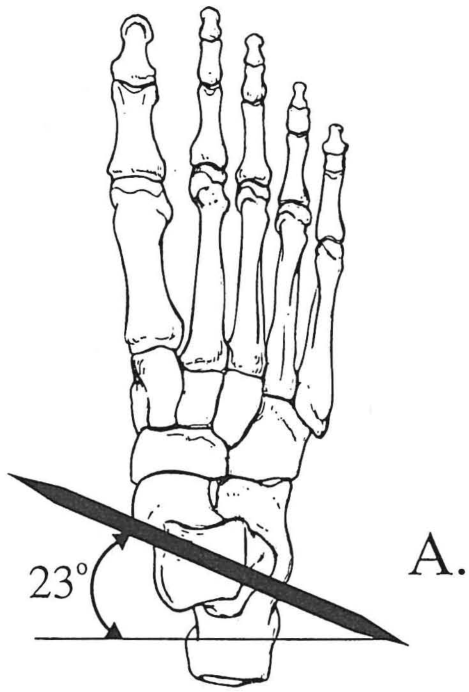


Figure 1. Talus width

dorsiflexion the wider anterior portion is described as "wedging" between the two malleoli, causing increased tension in the interosseous membrane and creating a stable close-packed joint. During plantarflexion the narrow posterior portion is brought between the malleoli, creating a more unstable joint and allowing the talus to move side to side and to rotate within the mortise.

A few degrees of motion may take place in the distal tibiofibular joint in order to accommodate the wedge-shaped trochlea during ankle motion.[29] Some authors contend that the fibula may rotate laterally a small amount in order to grip the talus more tightly during plantarflexion, thereby increasing stability.[24,25] Inman[26] has described the shape of the talus as a truncated cone, or a cone with either end cut off and lying on its side with its base directed laterally, rather than a wedge-shaped structure. He further attests that the talus is kept in close contact with the fibular and tibial malleoli throughout dorsiflexion and plantarflexion range of motion by slight lateral movement of the fibula with full dorsiflexion to accommodate the wider anterior trochlea.[24]

The axis of the talocrural joint passes through the distal tips of the lateral and medial malleoli (See figure 2). Since the lateral malleolus extends further distally and lies posterior to the medial malleolus, the axis is angled laterally 23 degrees in the transverse plane and 10 degrees from horizontal in the frontal plane.[24,26] The talocrural joint has one degree of freedom, allowing approximately 20 degrees of dorsiflexion and 30 to 50 degrees of plantarflexion. Although the talocrural joint is a hinge joint, due to the obliquity of the axis, the motions of plantarflexion and dorsiflexion do not occur in one plane, but rather in three planes. Dorsiflexion causes the foot to evert and abduct, while plantarflexion is accompanied by inversion and adduction of the



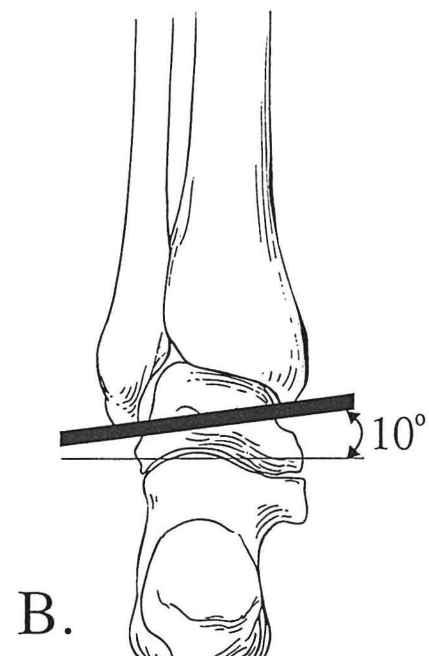


Figure 2. Ankle joint axis. A - superior view, B - posterior view

foot. This simultaneous motion in three body planes around a single axis is commonly referred to as triplanar motion.[24,28]

Stability of the talocrural joint is maintained by the shape of the ankle joint mortise, the medial and lateral collateral ligaments, and the position of the ankle at the time that stresses are applied to it.[24] The articular surface congruency of the ankle mortise contributes approximately 100% of inversion and eversion stability during closed kinetic chain or weight-bearing activities, but contributes none of the stability when the foot is not bearing weight.[24,30] This is provided primarily by the lateral collateral ligaments and the medial or deltoid ligament, which restrain inversion and eversion, respectively. Therefore, the ankle is unstable during loading and unloading of the joint but is usually stable when fully loaded. The stability of the ankle joint also changes with the position of the ankle. During dorsiflexion the stability of the ankle joint is provided by the tight fit of the wider portion of the talus within the mortise. When the narrow portion of the talus is within the mortise during plantarflexion, the collateral ligaments provide most of the stability. Due to these stability factors, the majority of the injuries to the ankle joint are inversion injuries occurring during loading of the joint when the foot is in a plantarflexed position.[31]

Ligaments

The ligaments of the ankle act to restrain extreme ranges of motion, thereby protecting the foot and ankle from improper loading and helping to prevent injuries.[25] The ankle joint is surrounded by a fibrous joint capsule, which is thin and weak anteriorly and posteriorly but is strengthened medially and laterally by the collateral ligaments.[26,28] The medial ligament complex, termed the deltoid ligament, is a very strong, fan-shaped collection of ligaments originating on the medial malleolus. This ligament is made up of four separate bands: the tibionavicular, the anterior talotibial, the calcaneotibial, and the posterior talotibial bands.[30] The function of the deltoid ligament is to limit valgus stresses and the extremes of eversion range of motion.[24] The posterior portion of the deltoid ligament is taut during dorsiflexion and lax during plantarflexion, while the anterior bands are taut with plantarflexion and slacken as the foot dorsiflexes.[27,30] This is due to the axis of the ankle joint being located distal to the attachment of the ligaments on the medial malleolus.

The lateral ligament complex is made up of three ligaments: the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL), and the posterior talofibular ligament (PTFL)[26] (See figure 3). The ATFL runs anteromedially in a slightly descending course from the anterior lateral malleolus to the body of the talus.[28] This intracapsular ligament is approximately 6 to 8 millimeters wide and 15 to 20 millimeters long. The ATFL runs parallel to the foot when the ankle is in a neutral position and parallel to the long axis of the tibia during plantarflexion.[21] The CFL courses inferiorly and posteriorly from the tip of the lateral malleolus to the lateral surface of the calcaneus.[27,30] This extracapsular ligament is 4 to 8 millimeters wide and 20 to 30 millimeters long.[21] It is a two-joint ligament crossing both the talocrural and posterior subtalar joints. The peroneus longus and brevis tendons lie immediately superficial to the CFL, with their synovial tendon sheaths attaching to the ligament. The PTFL is a strong, thick ligament running medially and almost horizontally from the posterior lateral malleolus to the posterior body of the talus.[28] This ligament is also intracapsular and is approximately 5 millimeters wide and 30 millimeters long.[21] The lateral ligaments function to

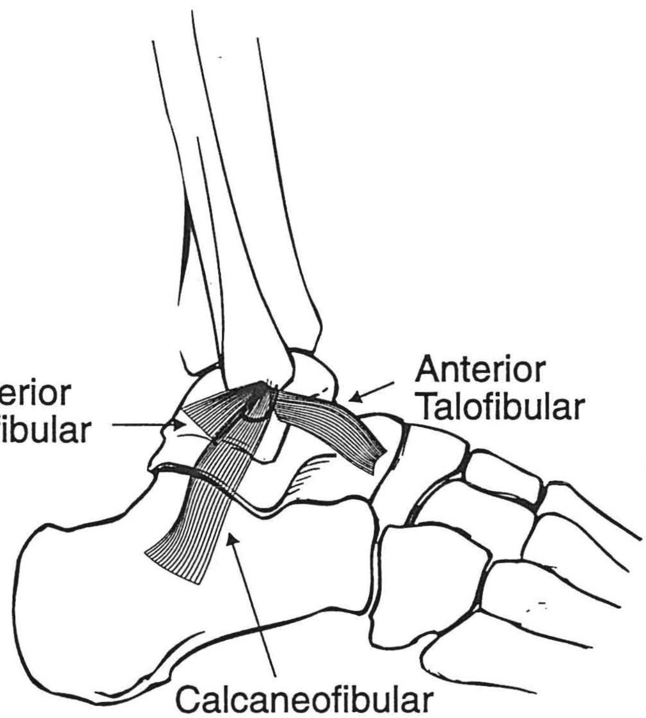


Figure 3. Lateral ankle joint ligaments

limit varus stresses on the ankle and to control extremes of inversion range of motion.[26] Because the axis of the talocrural joint is located at the distal tip of the fibula directly in the center of the attachment of the three ligaments, the lateral ligaments remain taut throughout the full range of motion.[25,27]

The ATFL limits talar tilt throughout range of motion but provides the most stability in plantarflexion.[28] When the ankle is positioned in plantarflexion, the ATFL becomes oriented almost vertically, thus providing maximum protection against inversion.[30] In a neutral or dorsiflexed position the ATFL is aligned almost horizontally and is less effective in resisting inversion. The CFL is most important for providing stability when the ankle is dorsiflexed. In this position the ligament is oriented almost vertically and functions as a true collateral ligament to resist inversion stresses; whereas in plantarflexion the CFL is positioned nearly horizontally and stabilizes only the subtalar joint.[30] The PTFL is also an important restraint to varus stresses when the ankle is plantarflexed due to its more vertical orientation in this position.

Muscular Control

The muscles and tendons surrounding the ankle joint may function to provide dynamic stability to the ankle, although their primary function is to provide mobility to the foot.[29] Plantarflexion of the foot is produced primarily by the gastrocnemius and the soleus muscles, collectively referred to as the triceps surae. The two heads of the gastrocnemius originate on the femoral condyles and insert into the posterior calcaneus via the Achilles tendon. The gastrocnemius functions to plantarflex the foot and assist with flexing the knee. The soleus originates from the posterior midtibia and posterior fibula and is also part of the Achilles tendon insertion into the calcaneus. In addition to plantarflexing the foot, the soleus is active during static stance to pull the body posteriorly when the body's center of gravity is shifted anteriorly.[27]

Dorsiflexion is produced by the tibialis anterior, peroneus tertius, extensor digitorum longus, and extensor hallucis longus muscles. The tibialis anterior runs from the lateral tibia and interosseous membrane to the medial cuneiform and base of the first metatarsal. This muscle is a prime mover for both dorsiflexion and inversion.[27] The peroneus tertius, which attaches to the distal anterior fibula and interosseous membrane and inserts on the medial side of the base of the fifth metatarsal, functions to dorsiflex and evert the foot. The extensor digitorum longus originates on the upper fibula and lateral tibia and divides into four tendons which insert into the distal phalanges of the four lateral toes via the dorsal expansion. In addition to dorsiflexion, the extensor digitorum longus extends the four lateral toes and assists with eversion of the foot. The extensor hallucis longus originates on the anterior fibula and interosseous membrane and inserts into the distal phalanx of the great toe. It functions to extend the great toe in addition to assisting with dorsiflexion. In a closed kinetic chain system, the anterior tibial muscles function to pull the tibia anteriorly, thereby pulling the body forward when the center of gravity is shifted posteriorly.[27] The anterior muscle group also assists with shock absorption during ambulation by eccentrically controlling the movement of the foot.[25]

Gait Biomechanics

In addition to controlling plantarflexion and dorsiflexion of the foot in a sagittal plane the talocrural joint functions to adjust the postural sway of the body during static stance. It also provides the propulsion force and restraint to motion required during the gait cycle through the concentric and eccentric contraction of the dorsiflexors and plantarflexors.[28] In static bilateral stance the ground reaction force passes anterior to the ankle and, therefore, produces a dorsiflexion force on the ankle.[27] Due to this force, static standing requires continuous activity of the plantarflexors to enable the body to remain in a balanced position.

The total joint range of motion possible in the ankle joint varies from 50 to 70 degrees. A much smaller range is required during gait, with approximately 10 degrees of dorsiflexion and 20 degrees of plantarflexion being used during normal walking speed.[32] At initial contact the ankle is in a neutral or slightly plantarflexed position. During loading response, the ankle continues to plantarflex to approximately 10 degrees. As the body moves over the foot during midstance, the ankle dorsiflexes to approximately 5 degrees of dorsiflexion and continues to dorsiflex during terminal stance until the ankle reaches 10 degrees of dorsiflexion. This maximum amount of dorsiflexion is reached just prior to heel off. During preswing the ankle plantarflexes to 20 degrees, begins to dorsiflex through the remainder of swing phase to enable the toe to clear the ground, and reaches neutral or a slightly plantarflexed position just prior to initial contact.

During gait the ankle joint is subjected to compressive forces equaling, on average, five times body weight.[30] When this immense force is suddenly imposed on an inverted ankle, it frequently causes severe ankle injuries. Each ankle joint supports approximately 50% of body weight in a neutral, weight-bearing position.[24] The fibula, which has previously been regarded as a non-weight-bearing structure, has recently been found to function as a weight-bearing surface, carrying as much as one sixth of the load of the ankle joint.[24,30] Therefore, the fibula, along with the interosseous membrane, functions to relieve the tibia of a portion of the weight-bearing load. The surface available for weight bearing in the talocrural joint has been found to range from 11 to 13 cm^2. [25] Due to this relatively large weight-bearing surface of the talocrural joint, the load per unit area in the ankle is less than that of the hip or knee.[24] However, ankle sprains or fractures, which may result in a lateral talar shift, can cause significant increases in the peak compressive loading on the ankle by slightly changing the amount of weight-bearing surface available in the ankle joint. The weight-bearing function and the amount of load transmitted across the joint is an important consideration, since a very small amount of lateral talar displacement will cause a reduction in the weight-bearing surface available, thereby dramatically increasing the stress upon the tibial and talar surfaces still in contact and ultimately leading to degenerative changes.[25,29]

Subtalar Joint

Joint Structure

The subtalar joint has been referred to as the "determinative joint of the foot influencing the performance of the more distal articulations and modifying the forces imposed on the skeletal and soft tissues".[33]

The subtalar joint consists of the articulation between the calcaneus and the talus, with three articulating facets between the two bones.[24,25,28,30] The posterior articulation consists of a convex facet on the calcaneus and a concave facet on the body of the talus. It is encased in its own joint capsule. The anterior and middle articulations are made up of two concave facets on the calcaneus that articulate with two convex facets on the talar neck and body. These two articulations, as well as the talonavicular joint, are encased in a single joint capsule.

The subtalar joint axis has an average angle of 42 degrees superior to the horizontal in the sagittal plane and 23 degrees medial to the midline passing between the second and third toes in the transverse plane[24,25,26] (See figure 4). The subtalar joint has a wide range of inclinations in different individuals, varying from 29 to 47 degrees in the sagittal plane and from 8 to 24 degrees in the transverse plane.[26] The movement around this single oblique axis is described as the triplanar motions of pronation and supination.[24,25] Subtalar joint pronation is a combination of calcaneal eversion, abduction, and dorsiflexion and is the position of mobility. Supination contains the component motions of calcaneal inversion, adduction, and plantarflexion and is the close-packed position of the subtalar joint. The variation of the axis inclination determines the amount of each component motion. If the axis is projected more horizontally, the amount of inversion and eversion will exceed the amount of abduction and adduction, but if the axis is more vertical, abduction and adduction will predominate.[26] The component motions of plantarflexion and dorsiflexion are greater if the axis is projected further medially from midline.

Although the subtalar joint axis varies among individual ankles, for clinical purposes there is a subtalar joint neutral position. This position is found by palpating the medial and lateral talus on the dorsum of the foot and by pronating and supinating the foot until the dome of the talus is palpated evenly medially and laterally or is not palpated at all on either side. Clinical rearfoot and forefoot measurements may be made with the foot in subtalar joint neutral. Because triplanar motions are difficult to measure, range of motion of the

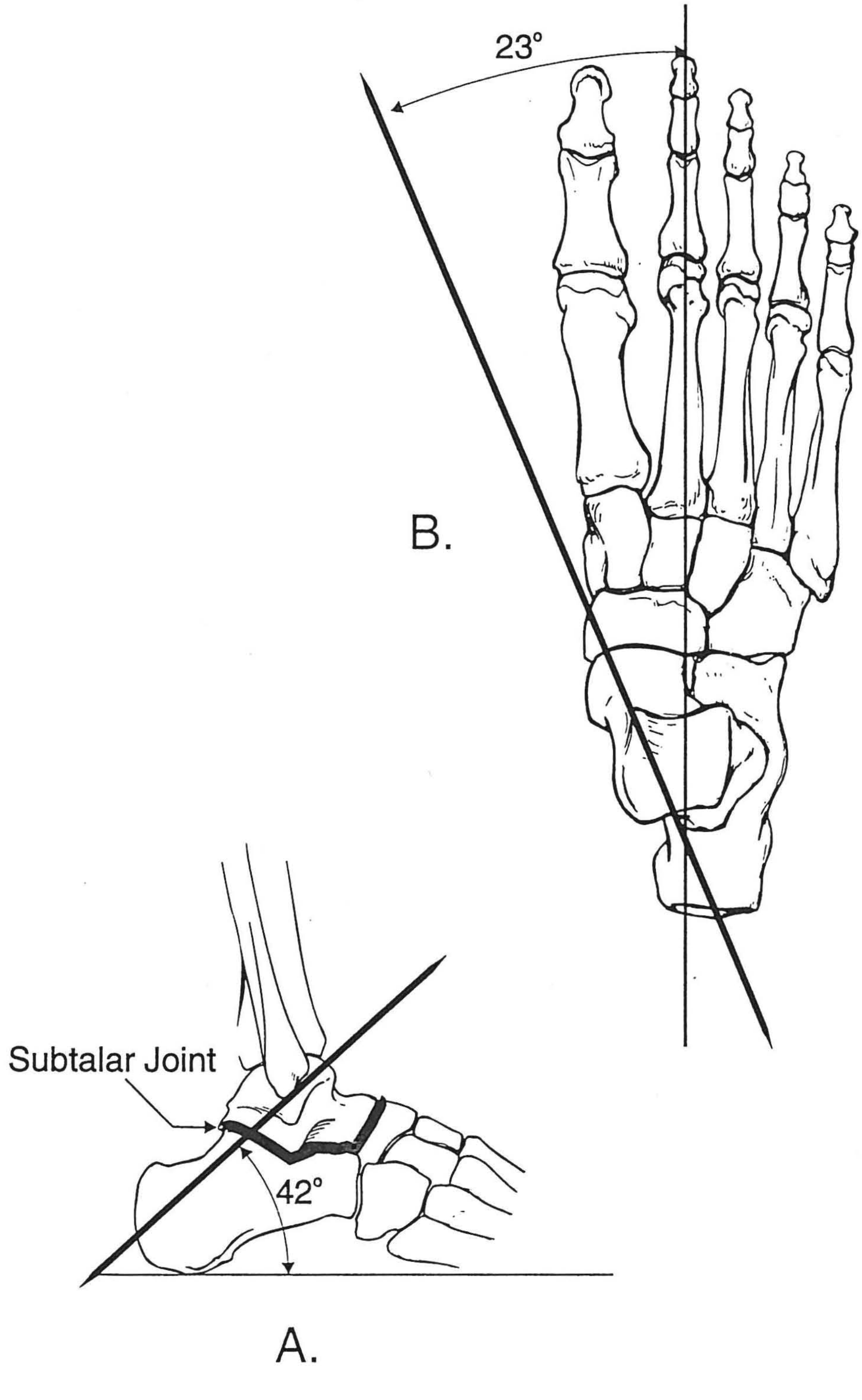


Figure 4. Subtalar joint axis. A - lateral view, B - superior view

subtalar joint is usually assessed clinically by measuring calcaneal eversion and inversion. The average range of calcaneal motion has been measured as 20 degrees of inversion and 10 degrees of eversion.[24,26]

Ligaments

The ligaments supporting the subtalar joint provide strong stability to the joint. Harper[22] has classified the subtalar ligaments into three layers: the superficial layer consists of the lateral talocalcaneal ligament, the calcaneofibular ligament, and the lateral portion of the inferior extensor retinaculum; the ligamentum cervicis and intermediate portion of the retinaculum make up the intermediate layer; and the deep layer consists of the interosseous ligament and medial portion of the retinaculum. The major stabilizers of the subtalar joint are the interosseous talocalcaneal ligament and the ligamentum cervicis. The interosseous talocalcaneal ligament runs within the tarsal canal from the talus to the calcaneus.[26,28] It divides the posterior facet from the anterior and middle facets and is positioned perpendicular to the joint axis, with the strongest portion of the ligament lateral to the axis. This position allows the ligament to become taut during inversion and slack during eversion, therefore, providing more stability to the supinated foot.[24,25,27] The ligamentum cervicis is a smaller ligament connecting the talus and calcaneus, but positioned lateral to the talocalcaneal ligament.[24,25,26,28]

Muscular Control

The motions of calcaneal inversion and eversion occur primarily around the subtalar joint axis, with inversion being produced primarily by the tibialis posterior and tibialis anterior, and the motion of eversion being controlled by the peroneus longus, brevis, and tertius and the extensor digitorum longus. The tibialis posterior originates on the posterolateral tibia, posterior fibula, and interosseous membrane and inserts onto the base of the second, third, and fourth metatarsals. It functions to control the motions of plantarflexion and inversion. The peroneus longus originates on the proximal lateral fibula, runs under the foot, and inserts into the base of the first metatarsal. The peroneus brevis attaches to the distal lateral fibula and courses down to the lateral side of the base of the fifth metatarsal. Both of these muscles function to evert the foot. The tibialis anterior, peroneus tertius, and extensor digitorum longus, which were discussed earlier, also play a role in muscular control across this joint.

Gait Biomechanics

The subtalar joint functions to convert the foot from a mobile structure at heelstrike, which allows the foot to accept uneven terrain and absorb shock, to a rigid structure at toe off, which functions to propel the body forward.[30] During weight-bearing motions of the subtalar joint, the calcaneus is able to invert and evert, but is not able to abduct/adduct or plantarflex/dorsiflex.[26] Therefore, these other two components of subtalar motion have to be accomplished by the talus and its proximal articulation with the tibia. The talus is able to slide anteriorly and posteriorly within the mortise to absorb the component motions of dorsiflexion and plantarflexion, but since it cannot rotate within the mortise, the abduction and adduction component is transferred to the tibia, causing it to internally and externally rotate.

The closed kinetic chain responses of the subtalar joint directly influence the joints proximal to it and provide the joint with an ability to transmit rotational torque from the lower leg across the joint.[24,26] During gait the tibia rotates an average of 19 degrees as the body passes over the fixed foot. This rotation is converted to pronation and supination in the subtalar joint.[30] From initial contact to loading response, the tibia internally rotates, causing the talus to plantarflex and adduct as the calcaneus everts. This motion is referred to as closed kinetic chain pronation.[24] During midstance the foot assumes a neutral position; but as the heel leaves the ground, the tibia externally rotates, causing the motions of calcaneal inversion, talar dorsiflexion, and talar abduction, which are collectively referred to as closed kinetic chain supination. Throughout the gait cycle the subtalar joint has been found to have an average of six degrees of range of motion.[24,29]

When chronic lateral ankle instability develops following an acute ankle injury, a thorough understanding of the anatomy and biomechanics of the talocrural and subtalar joints will help clinicians perform a comprehensive evaluation of these joints and, therefore, determine the extent of chronic instability. The type of instability, mechanical or functional, may also be determined following a thorough subjective and objective examination.

MECHANICAL AND FUNCTIONAL INSTABILITY

Chronic instability may develop secondary to recurrent sprains, ankle fractures, severe acute ankle sprains, and a high post-injury activity level.[31] The severity of the initial ankle injury does not appear to correlate with the severity of residual symptoms. The diagnosis of chronic lateral ankle instability is made following a subjective and objective examination. The patient's subjective description of pain, swelling, a feeling of the ankle giving way, or recurrent sprains, all of which may occur with sports activities or normal daily activities, indicates the presence of chronic instability.[1,23,31] The objective findings of edema, tenderness, joint crepitus, decreased range of motion, positive anterior drawer or talar tilt tests, positive stress radiographic findings, peroneal muscle weakness, or decreased proprioceptive control further confirm the diagnosis of chronic instability.

Chronic instability is commonly classified into two catagories: mechanical and functional.[1,5,6,7] Mechanical instability is a term used to define an objective clinical measurement of motion exceeding the physiological range of motion.[1] Functional instability is generally defined as the patient's subjective description of the ankle repeatedly giving way.[13]

Mechanical Instability

Mechanical instability is most often assessed clinically utilizing the anterior drawer and talar tilt tests or radiographically using stress x-rays. The anterior drawer test is performed with the patient positioned supine or sitting.[7,31] The distal tibia is grasped with one hand and the talar dome with the other hand, and as the talar dome is stabilized, a posteriorly directed force is applied to the tibia. This test measures anterior translation of the talus on the tibia and primarily assesses the integrity of the anterior talofibular ligament, which is the principle restraint to anterior talar translation in the ankle joint.[34] The talar tilt test is also performed with the patient positioned sitting or supine.[7,31] The heel is grasped with one hand and the distal tibia with the other hand, and an inversion stress is applied to the calcaneus while the tibia is stabilized. This test assesses the amount of inversion occurring between the talus and calcaneus. When this test is performed with the ankle in plantarflexion, the integrity of the anterior talofibular ligament is assessed; and when the ankle is positioned in neutral or dorsiflexion, the calcaneofibular ligament is primarily evaluated.[34]

Stress radiographs can be used to confirm mechanical instability by measuring the amount of anterior talar translation and the amount of inversion using the anterior drawer and talar tilt tests, respectively. These tests may be performed either manually or with commercially available stressing jigs. Karlsson[35] has defined mechanical instability radiographically as an anterior talar translation equaling or exceeding 10 millimeters or a talar tilt equaling or exceeding 9 degrees. An ankle may also be considered mechanically unstable if the change in anterior talar translation is greater than or equal to three millimeters or if the change in talar tilt is greater than or equal to three degrees when each test is compared to the contralateral stable ankle.

Mechanical instability may be symptomatic or asymptomatic with symptoms including recurrent swelling, pain, tenderness, decreased range of motion, joint crepitus, and stiffness with activity.[7,23,34] Brostrom found that only one half of patients demonstrating a positive anterior drawer test exhibited symptoms of chronic instability.[36]

Functional Instability

Freeman[13] first used the term functional instability to describe the patient's subjective complaint of the ankle repeatedly giving way. He reported that functional instability follows as many as 40% of acute lateral ligament injuries.[12] Tropp[8] further defined functional instability as motion beyond voluntary control but not necessarily exceeding the physiological range of motion. Functional instability usually occurs with sports activities or during activities of daily living such as walking on uneven ground, pivoting, or descending stairs.[7] Patients may complain of frequent giving way, recurrent sprains, difficulty walking or running on uneven surfaces, difficulty jumping and cutting, and chronic swelling.

Functional instability constitutes the most common and most serious disability following an acute lateral ligament injury.[6] A complex interaction of mechanical, functional, and neuromuscular deficits may lead to the development of functional instability.[5,6] Although the exact cause is still unknown, five primary factors have been proposed to contribute to functional instability. These factors include rupture or elongation of lateral ligaments,[10,15,16] proprioceptive disorders,[8,9,13,14,17,18] peroneal muscle weakness,[8,16,19] subtalar instability,[20,21,22] and chronic tibiofibular sprains.[16,19,21] It has also been suggested that several other factors may play a part in the development of functional instability, including pathological joint laxity, pain secondary to an impingement, limited mobility of the ankle joint due to the formation of adhesions, peroneal tendon subluxation or dislocation, traction injuries of superficial peroneal or sural nerves, varus foot, and Achilles tendon tightness.[2,7,12,13,20,31,34] Additional external predisposing factors may include poor footwear, inadequate or inappropriate rehabilitation following a sprain, premature return to full activity, or inadequate external support.[23]

ETIOLOGICAL FACTORS

The five primary etiologic factors of chronic lateral ankle instability, particularly functional instability, include the rupture or elongation of ligaments (i.e. mechanical instability), proprioceptive deficits, peroneal muscle weakness, subtalar instability, and chronic tibiofibular sprain.

Rupture or Elongation of Ligaments

The rupture or elongation of ligaments, which often indicates mechanical instability, has been a commonly proposed factor contributing to functional instability, although there has been considerable controversy over the correlation between mechanical and functional instability. Several authors contend that there has been no correlation demonstrated between mechanical and functional instability of the ankle, but that they may be parallel phenomena.[8,11,12,13,14] Tropp[8] demonstrated that greater than one half of functionally unstable ankles were found to be mechanically unstable. He further demonstrated that the ability to maintain postural equilibrium is reduced in subjects with functional instability but is not affected by mechanical instability. Conversely, in a study using stress radiographs, Karlsson et al[9] demonstrated that a correlation between mechanical and functional instability exists.

Proprioceptive Deficits

Proprioceptive deficits in the ankle have been extensively studied as a probable cause of functional instability. The ability to maintain postural equilibrium in standing is determined by three systems: the visual, the vestibular, and the somatosensory systems.[11] In normal adults the primary system responsible for postural control is the somatosensory system, which primarily involves proprioception. Mechanoreceptors located in the joint capsules and ligaments of the ankle provide the major stabilization to postural sway under normal conditions.[37] The mechanoreceptors of the ankle travel to the central nervous system for processing via afferent nerves. Efferent nerves in turn connect the central processing centers to the muscles surrounding the ankle where postural corrections are made as necessary.

Freeman[13] and Tropp[8] both proposed that ankle stability depends upon an intact proprioceptive reflex mechanism, which they based upon the findings of a correlation between functional instability and impaired postural control during single limb stance. Freeman[13] postulated that damage to joint and/or muscle mechanoreceptors may cause proprioceptive deficits in the ankle joint. He further suggested that ligament trauma may lead to partial deafferentation of the nerves that innervate the joint capsule and ligaments, resulting in persistent functional instability.

Since 1965 when Freeman first proposed his theory that functional instability is due to a proprioceptive deficit in the ankle, several studies have been performed to try to establish a connection between proprioceptive loss and chronic ankle instability.[2,8,11,12,18,38,39,40] In a study performed by Freeman et al[12] an attempt to correlate proprioceptive deficits with instability was made using a modified Romberg test, in which the patient stood first on the uninvolved foot and then on the involved foot with the eyes open, then closed. The patient's postural stability on the involved foot was compared to that on the uninvolved foot as measured by the investigators' objective observations and the patient's subjective report of postural sway. The results of this study revealed that 34% of patients with functional instability had a positive modified Romberg test, and that this percentage was reduced to 7% following a therapy program that addressed proprioceptive training. Therefore, the authors concluded that diminished proprioception may be responsible for functional instability in the ankle. Konradson and Ravn[18] have substantiated Freeman's deafferentation theory in a study measuring peroneal reaction time to sudden inversion stress on the ankle. In this study unstable ankles showed a prolonged peroneal muscle reaction time, indicating a deficit in the reflex stabilization around the ankle and suggesting that a partial proprioceptive deafferentation may be responsible for the development of functional instability.

Karlsson et al,[17] using electromyograpic (EMG) measurements, found a significantly longer reaction time of the peroneus longus and peroneus brevis in mechanically unstable ankles as compared to stable ankles when the ankles were subjected to a sudden inversion stress. The reaction time has been defined as the difference between the start of ankle inversion and the first muscle response registered on the EMG. From this study the authors concluded that functional instability may be caused by a combination of mechanical instability and a proprioceptive deficit. Additional studies have found evidence of delayed peroneal muscle response times in chronically unstable ankles, which supports Freeman's proposal of a proprioceptive deficit leading to functional instability.[18,39]

The cause of proprioceptive deficits in the ankle that lead to functional instability has been the subject of much debate. A procedure used to objectively study postural equilibrium, called stabilometry, has been employed to determine if a correlation between postural sway and instability, whether functional or mechanical, exists.[11,23,38,41] In this procedure the patient stands on a force platform and the center of force is measured in the lateral and sagittal planes. The amount and frequency of postural sway amplitude are then calculated by a computer. Tropp[8] was able to establish a correlation between functional instability and diminished postural control as measured by stabilometry. In another study by Cornwall and Murrell[38] postural sway amplitude, as measured by stabilometry, was found to be significantly greater in subjects with ankle inversion instability as compared to subjects with normal ankles. They further concluded that the increase in postural sway amplitude, which indicates a proprioceptive deficit, may be the result of increased ligament and joint laxity rather than deafferentation as was previously proposed by Freeman.

Peroneal Muscle Weakness

The results of the studies on increased peroneal reaction times in functionally unstable ankles are usually attributed to a proprioceptive deficit, but they may actually indicate peroneal muscle weakness, which has been implicated as another possible cause of functional instability.[16,19,42,43] In his study Tropp[42] demonstrated a correlation between functional instability and isometric peroneal weakness as measured by the Cybex II dynamometer. Joint or muscle damage may cause an increased risk of chronic reinjury to the ankle due to a loss of proprioception or to a decreased ability of the muscles to protect the joint from reinjury.[2] When muscle damage occurs following an ankle injury, weakness of the peroneal muscles results, removing what is thought to be the last defense mechanism against lateral ankle injury.[19] One study reported that 66% of patients exhibiting residual instability presented with peroneal weakness.[43]

Subtalar Instability

Subtalar instability has been cited as another possible predisposing factor of functional instability.[20,21,22] Clanton[20] stated that instability of the subtalar joint following inversion stress injuries to the lateral ankle can lead to chronic lateral ligamentous instability. He further concluded that subtalar instability should be evaluated as a possible contributing factor in cases of chronic instability. Talocrural and subtalar instability may occur simultaneously and are instabilities between which it is very difficult to distinguish. This leads to the assumption that the two types of instability are closely related.[21]

Subtalar instability is assessed by examining the tilt or gapping occurring between the posterior facets of the talus and calcaneus.[21] Excessive tilt in the involved ankle compared to the uninvolved ankle may indicate elongation or rupture of the subtalar ligaments, including the lateral talocalcaneal ligament, the interosseous talocalcaneal ligament, or the ligamentum cervicis.

Chronic Tibiofibular Sprains

A fifth proposed predisposing factor of chronic ankle instability is chronic sprains of the distal tibiofibular joint.[16,19,21] Tibiofibular sprains are also referred to as syndesmosis injuries or diastases of the ankle joint.[21,42] The syndesmosis consists of the anterior and posterior inferior tibiofibular ligaments, the interosseous ligament, and the interosseous membrane. It is an extremely strong structure, although it may be injured in external rotation injuries of the ankle joint.

The rupture of the inferior tibiofibular ligaments or damage to the interosseous membrane leads to a separation of the distal ends of the tibia and fibula, causing a diastasis or widening of the ankle mortise.[21,42] When this happens, the talus is able to move side to side within the mortise or rotate about its long axis, ultimately leading to chronic instability of the ankle joint.[28]

Syndesmosis sprains occur in as many as 10% of all ankle sprains.[21] Many of these sprains go undiagnosed and may lead to chronic pain and instability. Tibiofibular sprains usually produce more disability and longer periods of missed playing time than do lateral talocrural sprains. The "squeeze test" is used in the evaluation of tibiofibular sprains and is performed by compressing the tibia and fibula together at mid calf.[7] Pain or tenderness at the syndesmosis or ankle joint indicates a positive test. An external rotation stress radiograph is used to confirm the diagnosis. Chronic tibiofibular sprains may cause significant arthritis within the joint.[21] Therefore, acute injuries need to be accurately diagnosed and treated appropriately.

Although several possible causes of chronic lateral ankle instability have been researched, the exact etiologic factors involved are still relatively unknown. The identification of these etiologic factors, as well as additional predisposing risk factors, is extremely important for the implementation of a comprehensive rehabilitation program. When the causative factors are able to be identified, the rehabilitation program focuses on these factors in an attempt to correct them.

REHABILITATION

Approximately 80% to 90% of acute lateral ligament injuries will regain good functional stability with proper conservative treatment.[5,6] In the 10% to 30% of patients who develop chronic instability following acute injuries, a functional rehabilitation program is implemented to restore normal stability to the ankle joint.[6,7] Several authors suggest instituting a conservative treatment program for chronic instability prior to surgical intervention.[1,5,6,7,31] The benefits of conservative management over surgery include the lower cost of nonoperative treatment, no additional tissue trauma, and less risk of infection.[6] In one study the nonoperative treatment of functional instability in soccer players resulted in objective and subjective improvement of instability.[8] According to Karlsson et al,[15] nearly 50% of patients with chronic functional instability will regain stability after approximately 12 weeks on a rehabilitation program emphasizing strengthening of the peroneal muscles and neuromuscular proprioceptive training.

Since both functional instability and mechanical instability increase the possibility of degenerative changes in the ankle joint, restoring normal stability to an unstable ankle is extremely important.[23] When chronic instability occurs, abnormal motion of the talus within the mortise usually ensues, which causes abnormal loading and compressive forces in the ankle joint, damaging cartilage and leading to degenerative joint disease. Using roentgenograms and arthroscopy, Harrington[44] discovered degenerative changes in more than 75% of subjects demonstrating significant functional instability. In light of these findings, a treatment program focusing on regaining stability in the ankle joint should be instituted in patients with functional or mechanical instability.

The functional rehabilitation program generally used for the treatment of chronic lateral ankle instability consists of four primary components: Achilles tendon stretching, peroneal muscle strengthening, proprioceptive retraining, and external ankle bracing.[1,7,23,31]

Achilles Tendon Stretching

A decreased range of dorsiflexion motion of the ankle has been associated with complaints of functional instability and pain.[45] The first component, Achilles tendon stretching, increases this range of dorsiflexion motion, which may help to decrease the incidence of recurrent sprains and, therefore, decrease functional instability.[7,23] A tight Achilles tendon may predispose a person to inversion injuries by limiting dorsiflexion and placing the foot in a more plantarflexed position, thereby increasing the tendency for the foot to invert with weight bearing. In a study comparing athletes who stretched their Achilles tendon with those who did not, preinjury stretching was found to decrease the amount of time lost in sports activities following inversion injuries.[23]

The gastrocnemius muscle can be stretched using the wall stretch, in which the patient leans against the wall with the affected leg extended behind and the knee straight. The soleus muscle can be stretched in the same manner, but with the knee flexed[31,46,47] (See Appendix). An alternate method for stretching the Achilles tendon involves having the patient stand on an incline board with the knee straight to stretch the gastrocnemius muscle and with the knee flexed to stretch the soleus muscle.

Peroneal Muscle Strengthening

The peroneal muscles and other muscles surrounding the ankle are important for providing dynamic stability to the joint.[23] Therefore, the second element of a successful rehabilitation program involves muscle strengthening, which can be accomplished using isometric, isotonic, and isokinetic exercises. Isometric strengthening is essentially performed by everting, inverting, dorsiflexing, or plantarflexing the affected foot against a wall or other stable surface and maintaining an isometric contraction.[7]

Isotonic strengthening can be performed with Theraband, surgical tubing, or weights and should incorporate both concentric and eccentric muscle contractions.[7,31,47] The peroneal muscles can be strengthened with the patient sitting on the floor or a mat with one loop of the Theraband or tubing wrapped around the involved forefoot and the other end secured to a table leg or other stable surface or held by another person. The affected foot is then everted against the resistance and slowly returned to neutral, achieving both a concentric and eccentric contraction (See Appendix). The dorsiflexor muscle group can be strengthened by having the patient sit on the floor or the edge of a table with one end of the Theraband or tubing wrapped around the affected forefoot and the other end around the table leg while dorsiflexing the involved foot against the resistance (See Appendix).

Additional isotonic strengthening exercises can also be performed with ankle weights wrapped around the forefoot to provide resistance.[31] To strengthen the evertors, the patient can lie on his unaffected side and evert the affected foot against gravity and the resistance of the weights in a concentric and eccentric manner. Dorsiflexor strengthening can be accomplished by having the patient sit on the edge of a table with weights around the forefoot and dorsiflex against gravity and the resistance of the weights. One suggested protocol begins with two to five pound weights, progressing up to five percent of the patient's body weight.[31]

Isometric exercises and resistance exercises similar to those described for the evertors and dorsiflexors may also be used to strengthen the invertors. The plantarflexor muscles may be strengthened using closed kinetic chain exercises, including toe raises using a stool or step, and exercises on the standing and sitting calf machines or the leg press machine.[46,47] Heel and toe walking may be used to strengthen the dorsiflexors and plantarflexors.[46] By incorporating inversion or eversion into the heel and toe walking exercises, the invertor and evertor muscle groups are also strengthened.

Isokinetic strengthening exercises are performed on an isokinetic machine, such as the Cybex or KinCom. One author advocates beginning isokinetic strengthening when the patient has at least 75% range of motion.[31] He also maintains that muscle strength may be increased to a greater degree with isokinetic exercises than with isometric or isotonic exercises. The isokinetic program should incorporate both concentric and eccentric training for maximum strengthening results.

The emphasis for muscle strengthening should be placed on the dorsiflexors and evertors, since these muscle groups most often exhibit weakness, although the plantarflexors and invertors may also be strengthened as long as a balance among all muscle groups surrounding the ankle is achieved.[7] The goals for strengthening are to achieve an evertor to invertor strength ratio of 80% and a less than 10% difference in muscle strength between the involved ankle and the normal contralateral ankle, generally evaluated isokinetically.[31,48]

Proprioceptive Retraining

The third component, proprioceptive retraining, has been identified as an essential factor in the functional rehabilitation program. Investigators have shown a significant decrease in incidence of recurrent sprains and a restored postural correction system in patients who underwent proprioceptive retraining.[45] In a study by Tropp et al,[41] soccer players were tested for proprioceptive deficits using stabilometry at one week and three weeks postinjury and again six weeks following the completion of an ankle disc proprioceptive training program. The results showed a significant decrease in giving way of the ankle, indicating that proprioceptive training reduces the incidence of functional instability. Freeman et al[12] found similar results in a study in which functionally unstable ankles were treated with a coordination exercise program using ankle tilt boards. Following coordination training, the incidence of both a proprioceptive deficit and the symptom of giving way were significantly reduced. Other investigators have also found significant decreases in the incidence of chronic instability in patients treated with proprioceptive training.[8,49]

The goals of proprioceptive retraining are to restore neuromuscular control to a preinjury level and to reestablish protective reflexes.[6,23] The proprioceptive retraining program may begin by having the patient stand on the involved leg, first with the eyes open and then with the eyes closed to decrease visual input and, therefore, increase proprioceptive input.[47]

The next step in proprioceptive retraining involves the use of ankle tilt boards, which are also known by several other names: balance boards, proprioceptive boards, bongo boards, wobble boards, ankle discs, or the Biomechanical Ankle Platform System (BAPS).[23,46,47] During the proprioceptive retraining program the patient progresses through a series of exercises on the ankle tilt board beginning with unidirectional drills and progressing to multidirectional drills. Unidirectional drills are performed on a board that allows tilting in only one plane. The patient can perform plantarflexion/dorsiflexion by placing the foot perpendicular to the axis of the board, inversion/eversion with the foot parallel to the axis of the board, and pronation/supination with the foot placed diagonally on the board at a 45 degree angle, in either tibial internal or external rotation (See Appendix). As proprioception improves, the patient may advance to a multidirectional board, which allows tilting in a multitude of planes and on which clockwise and counterclockwise circles and figure-of-eight drills may be performed (See Appendix).

The patient begins the proprioceptive training program with both feet on the board, progresses to only the involved foot on the board, and finally advances to “no hands” balance training.[23] Exercises may be performed with the eyes open or with the eyes closed to further influence proprioception. The BAPS board can be used to challenge the patient by increasing the size of the supporting balls under the platform.[47] As the patient’s balance ability increases, he or she may be further challenged by bouncing, throwing, and catching a ball while maintaining his or her balance on the multidirectional board.

External Ankle Support

The final essential component of the functional rehabilitation program is the use of an external ankle support. The effectiveness of ankle taping and bracing has been extensively studied, with the results primarily showing that external support helps decrease the incidence of recurrent ankle sprains and chronic instability.[1,7,47,50,51,52] The goals of providing external support to the ankle joint in patients with chronic instability are to protect the joint by controlling inversion, to prevent recurrent sprains, to provide stability until dynamic stabilizers are strengthened, and possibly to enhance proprioception in the ankle joint.[31]

External support helps increase ankle stability by holding the ankle in a neutral position, reinforcing the ligaments, and restricting extreme inversion motions.[51] In one study ankle taping has been found to decrease the incidence of ankle injuries in basketball players[22], although another study reports that tape loses 40% of its effectiveness after approximately 10 minutes of sports activity.[50] According to Karlsson et al,[54] ankle tape is considered to be effective in providing stability to the ankle joint. The authors propose that the tape acts to increase the proprioceptive function of the ligaments and joint capsule surrounding the ankle joint, thereby limiting extreme ranges of motion and resulting in shortened peroneal muscle reaction times.

Braces are advocated as being superior to taping because braces provide more effective inversion restriction, are easier to apply, can be readjusted to restore effectiveness, can be reused, and are less expensive than taping.[31,47,55] Braces function to resist inversion forces applied to the ankle and may possibly function to increase proprioception, thereby producing more effective muscular control.[55] Karlsson et al[17] found that external ankle support decreased functional instability by facilitating the proprioceptive function in the ankle. In this same study the investigators found that, although functional stability was improved, mechanical instability was not significantly altered with the application of external ankle support. In a study by Feuerbach et al,[40] application of an ankle brace was found to facilitate proprioception, which the authors proposed was due to the brace's ability to increase the afferent feedback from cutaneous mechanoreceptors.

In a study involving football players, ankle braces have been found to be more effective than tape in preventing ankle injuries.[52] There are several braces from which to choose, including the air stirrup, the ankle ligament protector (ALP), the modified Sarmiento brace, the cast brace, and the lace-up brace.[31] The air stirrup brace has been found to improve balance in subjects with normal ankles and with inversion injuries.[56] Subjects have also rated the air stirrup brace as being more comfortable than the ALP and the lace-up braces, which is an important factor to consider when patient compliance is an issue.[57] The ALP brace appears to be the most effective brace for restricting inversion. According to a study by Gross et al,[57] the ALP restricted ankle inversion to a greater degree than the air stirrup brace, which in turn was more effective in limiting inversion than the Swede-O lace-up brace.

In patients with chronic ankle instability external ankle stabilizers should be worn until the peroneals show good strength and endurance.[31] An ankle brace allows patients with demonstrated mechanical instability to continue to participate in stress activities such as sports.[7] External ankle support should be used for all activities during the rehabilitation phase to prevent repeated episodes of giving way, which can cause pain, reflex inhibition, and muscle atrophy, thereby negating previous training efforts. An ankle brace or taping is advocated during all activities of daily living until the patient is able to achieve full range of motion, minimal tenderness and swelling, and 75% strength in manual muscle testing or 90% strength in isokinetic testing.[23] The patient should continue to wear the brace or tape during sports activities until 100% strength, restored proprioception, and the ability to perform functional drills without the orthosis are achieved. In addition to ankle taping or bracing DeMaio et al[23] maintain that a patient's shoes should provide adequate support and stabilization to the ankle joint to help prevent recurrent sprains.

Training for the Athlete

An additional phase that may be incorporated into the functional rehabilitation program for the athlete is the preparation for return to full activity, including sports.[7,23,46,47] This phase begins with general functional activities and progresses through sport-specific drills. Functional training generally follows a sequence of progressively challenging activities, which may include heel and toe walking, running in straight lines, running in progressively smaller figure-of-eight loops, jumping, double leg hopping, and single leg hopping. Sport-specific drills are exercises that are tailored to the sport to which the athlete will be returning. Examples of sport-specific exercises include circle and backward running, side stepping, cariocas, cutting, and pivoting drills. When the athlete is able to perform all sport-specific drills at maximum speed, he or she may return to practice, and once full practice is tolerated, the athlete will be able to return to competition.

Athletic performance may also be enhanced by incorporating stretch-shortening drills, or plyometrics, into the rehabilitation program.[58] Stretch-shortening drills are designed to increase the maximum muscular force output generated in a minimal amount of time by stimulating proprioceptors and, therefore, increasing muscular recruitment and improving reactivity of the neuromuscular system. Plyometric drills utilize quick, powerful eccentric muscle contractions involving prestretching of the muscle, immediately followed by concentric contractions, in which maximal muscular contractions are produced. These types of drills are designed to be advanced strengthening exercises for the competitive athlete and are not intended for the recreational athlete.

When conservative methods fail, surgical intervention is often a necessity to restore normal stability to the ankle joint. Many surgical reconstructive procedures can be successfully performed several years after the initial ankle injury; therefore, initial conservative treatment should be instituted prior to surgical treatment.[6,21] Approximately 10% to 20% of all patients suffering acute lateral ligament ruptures will eventually require ligament reconstructive surgery, of which there are there are currently more than 50 reconstruction and repair procedures and modifications described in the literature.[7] The most common indications for surgical treatment of chronic instability are the presence of both mechanical and functional instability and the failure of conservative treatment. The postoperative protocol will depend primarily on the surgical procedure performed; although, following the initial acute stages of treatment, a functional rehabilitation program very similar to the conservative approach previously described in this chapter is often implemented.

Treatment of chronic lateral ankle instability involves the functional rehabilitation of the ankle to restore normal range of motion, increase dynamic stability, reestablish proprioceptive control, and protect the joint. The rehabilitation program consists of four essential components: Achilles tendon stretching, peroneal muscle strengthening, proprioceptive retraining, and the application of external ankle support. Additional range of motion, muscle strengthening, and functional and sport-specific training are incorporated into the program to fully rehabilitate the unstable ankle. In the patient that does not benefit from the conservative management of chronic instability, surgical intervention may be necessary to restore stability to the joint.

CONCLUSION

The prevention of chronic lateral ankle instability involves early treatment of acute ankle sprains with a functional rehabilitation program designed to restore full range of motion, strengthen the musculature surrounding the ankle joint, reestablish proprioception to the joint, and prevent recurrent injuries. Without adequate treatment of acute injuries, chronic instability may develop, although in some patients, instability still occurs following comprehensive treatment.

Two types of chronic lateral ankle instability have been described in the literature. The first, mechanical instability, is the objective measurement of excessive ankle range of motion due to the rupture or elongation of ankle ligaments. The second type, functional instability, is a subjective complaint of giving way in the ankle when performing daily activities or sports activities. Several factors have been theorized to lead to chronic instability. The five most commonly proposed factors include rupture or elongation of ligaments, peroneal muscle weakness, proprioceptive deficits, subtalar instability, and chronic tibiofibular sprains.

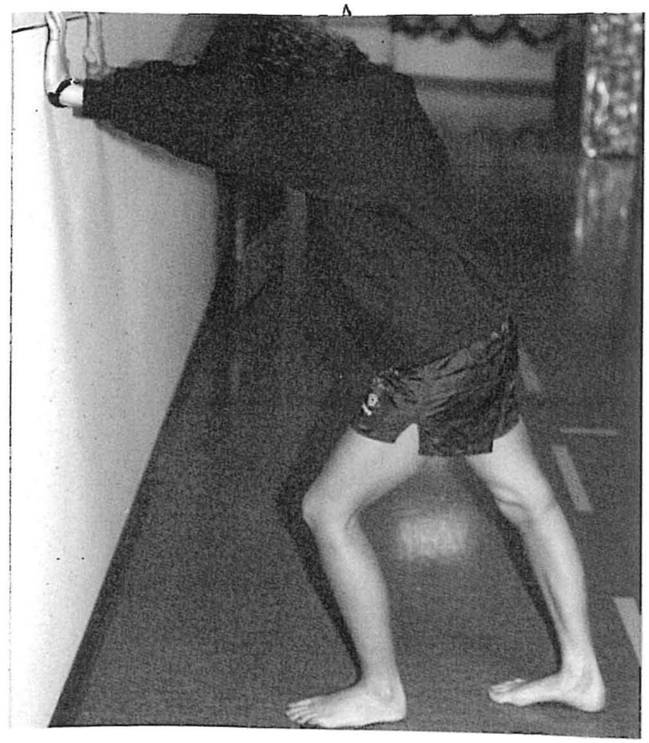
Clinicians should have a thorough understanding of the anatomy and biomechanics of the ankle joint and the extent of instability must be determined prior to making a decision about the treatment for patients with chronic lateral ankle instability.

The current focus of treatment for chronic lateral ankle instability is on an initial conservative approach prior to surgical intervention. The conservative management approach consists of Achilles tendon stretching, peroneal muscle strengthening, proprioceptive retraining, and external ankle support. In addition to these four primary treatment methods, range of motion exercises, strengthening of other muscles around the ankle joint, and general conditioning are incorporated into the treatment plan. For the athlete, functional training and sport-specific activities are implemented prior to the return to sports and high level activities. Surgical intervention is effective in restoring stability to the ankle joint but should be the treatment choice only after conservative treatment methods have failed.

APPENDIX

Achilles Tendon Stretching

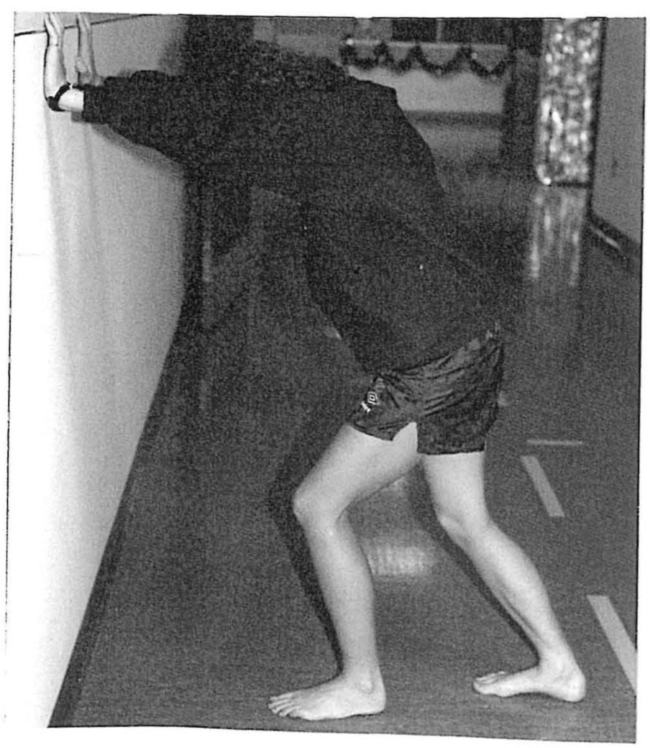
Wall Stretch



Stand with hands against the wall at shoulder level and the ______ foot in front. Lean into the wall, keeping the heel on the floor. Keep the back leg straight. Stretch is felt in the calf.

Hold ______ seconds.
______ repetitions.
______ times/day.

Modified Wall Stretch



Stand with hands against the wall at shoulder level and the ______ foot in front. Lean into the wall, keeping the heel on the floor. Bend the back knee slightly. Stretch is felt in the Achilles tendon.

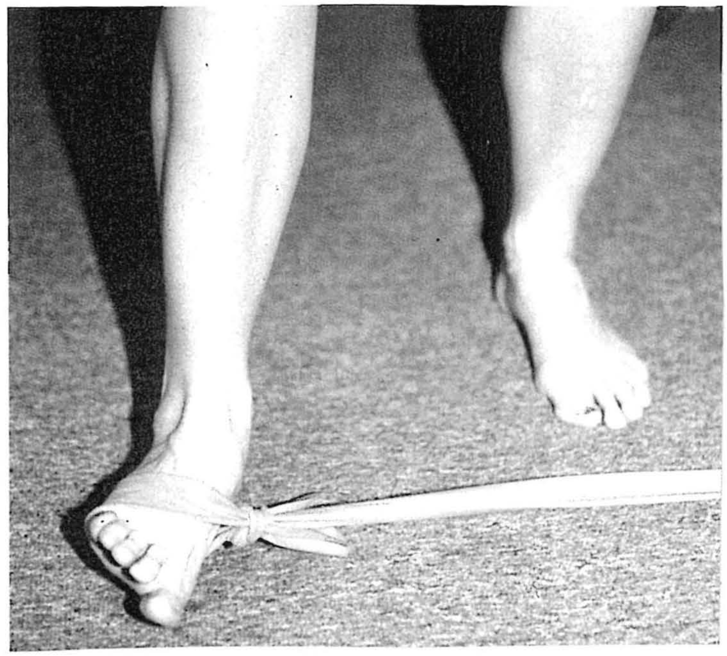
Hold ______ seconds.
______ repetitions.
______ times/day.

Muscle Strengthening

Theraband Strengthening
Eversion

Sit on the floor or a mat or bed with your legs straight. Place one loop of the theraband around the ______ forefoot. Tie the other end to a stable surface (i.e. table leg) or have someone hold it. Turn your foot out against the resistance to strengthen the muscles on the outside of your leg.

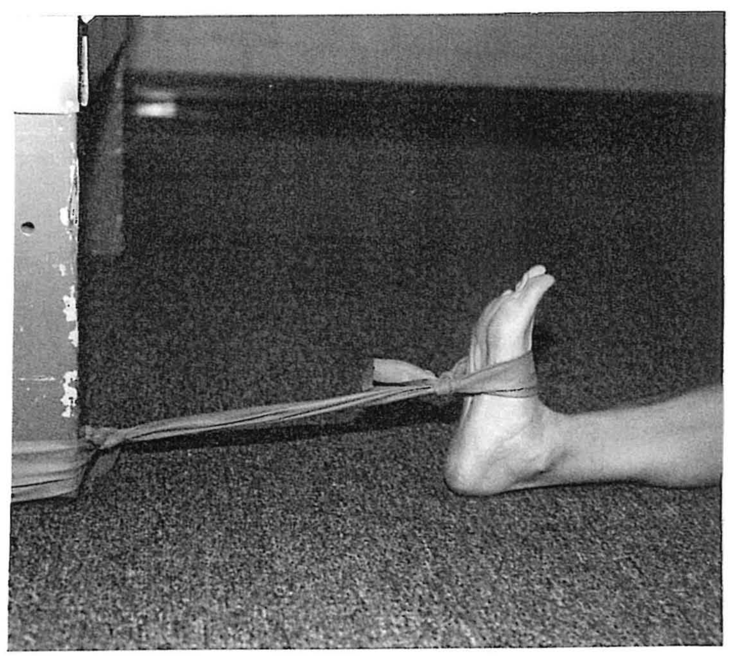
Hold ______ seconds.
______ repetitions.
______ times/day.



Theraband Strengthening
Dorsiflexion

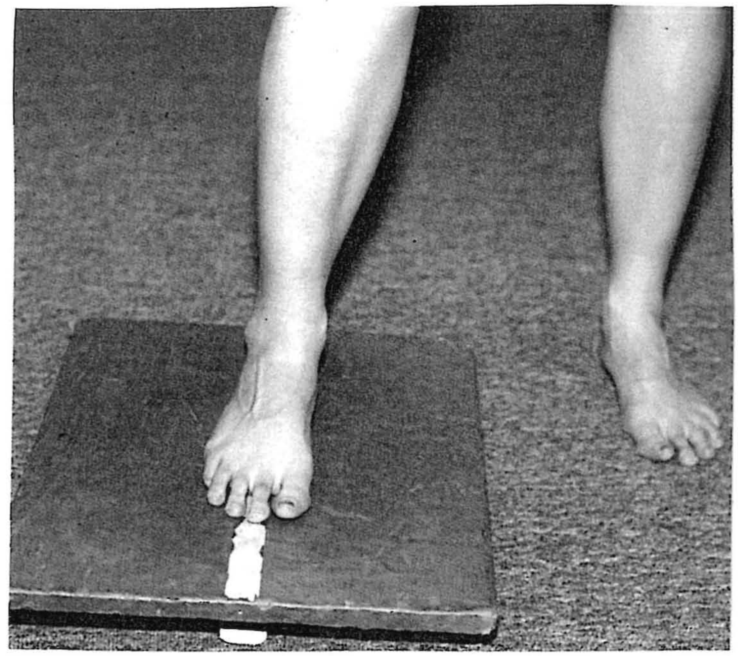
Sit on the floor or a mat or bed with your legs straight. Place one loop of the theraband around the ______ forefoot. Tie the other end to a stable surface (i.e. table leg) or have someone hold it. Pull the foot up towards you against the resistance to strengthen the muscles on the front of your leg.

Hold______ seconds.
______ repetitions.
______ times/day.



Proprioception Retraining

Unidirectional Inversion/Eversion

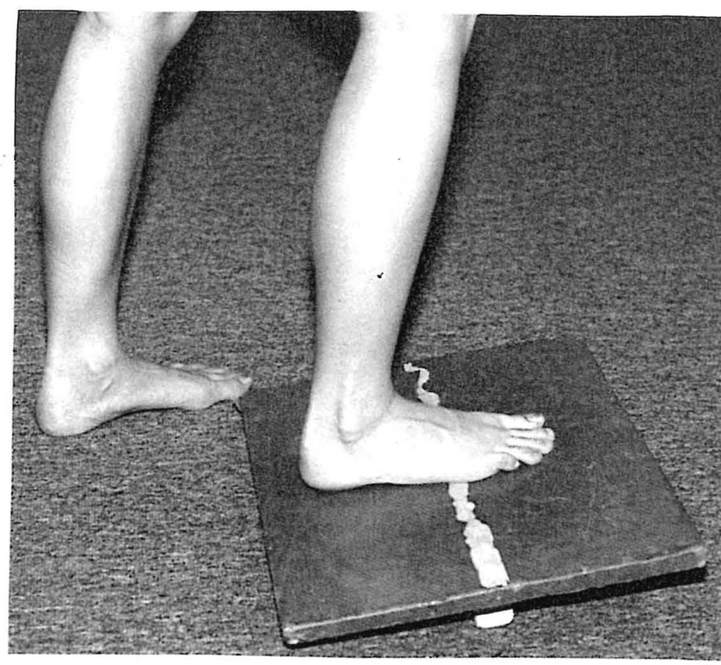


Stand on the tilt board with your ______ foot positioned parallel to the axis of the board. Shift your weight from side to side, tilting the board.

Progression:

1. Double leg support with hand support
2. Double leg support without hand support
3. Single leg support with hand support
4. Single leg support without hand support

Unidirectional Plantarflexion/Dorsiflexion



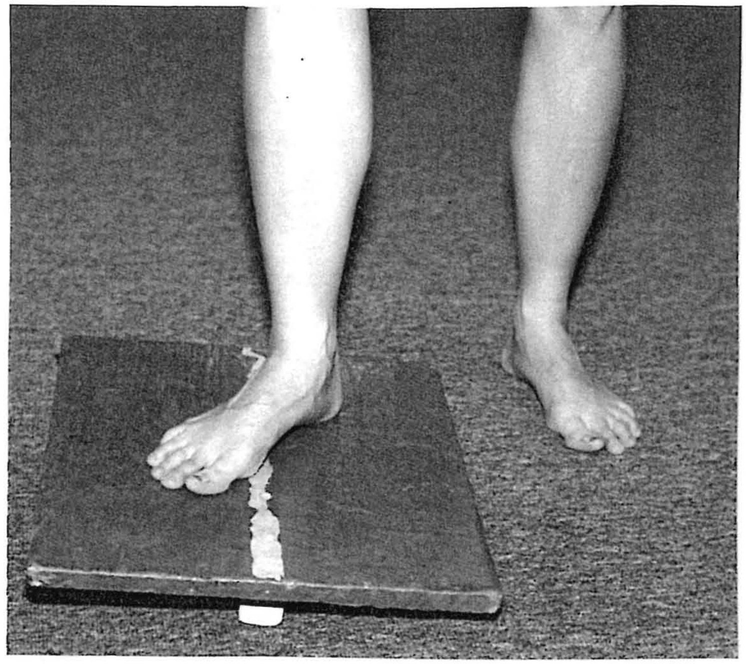
Stand on the tilt board with your ______ foot positioned perpendicular to the axis of the board. Shift your weight front to back, tilting the board.

Progression:

1. Double leg support with hand support
2. Double leg support without hand support.
3. Single leg support with hand support.
4. Single leg support without hand support.

Proprioception Retraining

Unidirectional Pronation/Supination

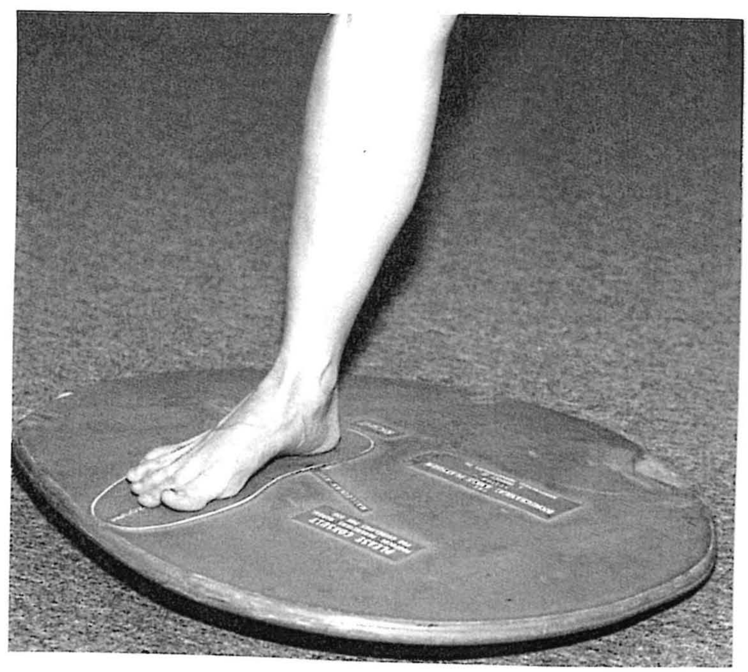


Stand on the tilt board with your ______ foot positioned at a 45 degree angle and your toes pointing either in or out. Shift your weight from side to side, tilting the board.

Progression:

1. Double leg support with hand support.
2. Double leg support without hand support.
3. Single leg support with hand support.
4. Single leg support without hand support.

Multidirectional



Stand on the multidirectional tilt board with your ______ foot. Shift your weight in clockwise and counterclockwise circles and figure-of-eight motions.

Progression:

1. Double leg support with hand support.
2. Double leg support without hand support.
3. Single leg support with hand support.
4. Single leg support without hand support.

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