Assessment of Ankle Joint Dorsiflexion: An Overview

Exploración de la flexión dorsal del tobillo: Una revisión

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ABSTRACT
The ankle joint is an important part of the musculoskeletal system necessary for normal ambulation. Reduced range of movement at this joint has been termed as *gastrocnemius contracture*, *limited ankle dorsiflexion* and *ankle equinus*. This condition has been related to various functional lower extremity musculoskeletal conditions.

This paper explores and provides an overview of ankle equinus, its effect on the lower extremities and some of the issues involved in the clinical measurement of ankle dorsiflexion.
Key words: Ankle Equinus; Goniometry.

RESUMEN
La articulación del tobillo es una parte importante del sistema musculoesquelético necesaria para la deambulación normal. A la reducción del rango de movimiento en esta articulación que se ha denominado como contractura de gemelo, flexión dorsal del tobillo limitado y equino del tobillo. Esta condición se ha relacionado con diversas condiciones patológicas funcionales de las extremidades inferiores musculoesqueléticos.

Este artículo explora y proporciona una visión general de equino de tobillo, su efecto en las extremidades inferiores y algunas de las cuestiones relativas a la medición clínica de la flexión dorsal del tobillo.
Palabras clave: goniometría; equino del tobillo.

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The ankle joint is formed by the articulation between the mortise of the lower tibia and fibula and the trochlear surface of the talus. Actually composed of 3 joints – the tibiotalar, tibiofibular and fibulotalar joints[1] – it plays an essential role during walking, and is of great importance during physical activities[2]. It is generally believed that the upward and downward movement of the foot, referred to as dorsiflexion and plantarflexion respectively, occurs mainly at this joint[3,2]. This Tibio-talar movement involves the rotation of the talus within the ankle mortise[4] with unresisted mobility being obtained by the sliding of the articular surfaces upon each other[5].

The ankle moves through an average of 20 º to 40 º total range of motion during walking[6]. Whilst this is a triplanar joint, the orientation of its axis, which runs from the medial to the lateral malleolus, facilitates the majority of this motion to occur in the sagittal plane. It is claimed that during normal locomotion, 10 degrees of ankle dorsiflexion is required for the forward translation of the centre of gravity of the body to occur during single limb support[3], although this has been challenged by various authors[6]. This forward translation occurs in the sagittal plane, and this is said to occur using a 3 rocker system to permit advancement[7]. This sagittal plane movement at the ankle occurs during the 2nd rocker[8].

1. LIMITED ANKLE DORSIFLEXION

Clinically, lack of ankle joint dorsiflexion is known by many terms, including *equinus*, *gastrocnemius contracture* and *limited ankle dorsiflexion*. The classical orthopaedic definition of ankle equinus is a plantarflexed foot as is often seen in neurological conditions such as cerebral palsy. Another definition is <10º of dorsiflexion with the subtalar joint placed at neutral position. This is thought to lock the midtarsal joint and reduce any movement extraneous to the ankle joint[3]. DiGiovanni et al (2002) defined *Equinus* as <5° of ankle dorsiflexion with the knee extended or <10° with the knee flexed and used the term '*gastrocnemius tightness'*[9].

The most common cause of Equinus is tightening or shortening of the gastocnaemius/soleus group (collectively known as the *triceps surae*), causing premature activity of ankle plantarflexors[10]. In fact, the term *muscular* ankle equinus has been coined . This is thought to result from modern lifestyle factors in the daily environment, which put patients at risk of developing this condition. These factors include overtraining of muscles, sleeping with the feet in a plantarflexed position for long hours and sitting for long hours at desks with the knees flexed and the feet in an equinus position[10]. Even during standing, the gastrocnaemius is being used to maintain the centre of gravity anterior to the ankle joint axis[11,12] and to oppose the dorsiflexing moment imposed on the foot[12].

2. EFFECTS OF ANKLE EQUINUS

Lack of ankle dorsiflexion is compensated for by altering gait, including early heel-off in mild cases (bouncy gait) or even a total lack of heel strike in severe cases (such as in cerebral palsy); triplanar rearfoot motion (pronation) and an adducted gait pattern.[3] Equinus can be uncompensated, with the patient walking on the toes, or compensated by various methods, including foot abduction, significant pronation of the mid foot and rearfoot, resulting in the loss of the medial longitudinal arch and abduction of the forefoot[13].

Once the ankle is restricted, the midtarsal joint is the next joint through which dorsiflexion may occur. This is achieved by excessive pronation of the foot[8], which turns it into a mobile adaptor to facilitate dorsiflexion at this joint. Forces on the midtarsal joint may eventually lead to the midfoot break and significant structural foot problems[14].

Lack of ankle dorsiflexion is said to produce a sagittal plane blockage[8]. This refers to a restriction of rotational motion of the foot or any part of it – such as the ankle and first metatarsophalangeal joint – within the sagittal plane. As the forward movement of the foot occurs mainly in the sagittal plane, anything that prevents this is likely to cause a change in gait and produce compensatory patterns of walking. In fact, *muscular* ankle equinus, or gastrocnemius contracture, has been linked to various foot conditions. In a study of 209 consecutive patients with musculoskeletal problems in the foot, a prevalence of 96.5% of this condition was found and has been linked to foot problems including plantar fasciitis and metatarsalgia[10].

Various authors claim that ankle equinus may be a significant causative factor of a variety of lower extremity conditions[3], ranging from low back pain, hyperextended knees, hallux rigidus, calcaneal spurs[15], chronic plantar heel pain[16], foot nerve entrapment[17], Achilles tendinopathy, Posterior Tibial Tendon Dysfunction, plantar fasciitis[10], metatarsalgia[18] and forefoot callus[19]. It has been shown that diabetic patients with equinus have significantly higher pressures in the forefoot than those without[20].

Although highly evident equinus may be a presentation of neurological conditions, including toe walking[21] and cerebral palsy[22], the milder form of equinus does not normally become apparent except through a thorough lower limb examination. This form of equinus can affect anyone, from diabetics[20,23], adolescent athletes[24] to children[25]. In individuals with neurological conditions, contracture of the triceps surae is well documented. The impact of contracture of the gastrocnemius in the normal patient needs to be researched more because it can have deleterious effects such as pain in the forefoot and/or midfoot[9].

3. EXAMINATION

Thus it is evident that ankle joint assessment, including measurement, is an important aspect of any musculoskeletal examination. A biomechanical evaluation of the foot normally starts with passive examination of this joint. Ankle joint movement examination may be performed using various methods. The procedures mostly used in clinics and research include goniometry[3,26] and visual estimation[27]. This may be because goniometers can be found easily in clinics and are relatively inexpensive. During goniometric examination, one arm of the goniometer is placed along a bisection of the lateral aspect of the lower leg, and the other arm along the lateral margin of the foot[3,26]. The subtalar joint is held in neutral position, with the midtarsal joint locked. An upward force is applied until the maximum ankle joint range of motion is reached. This examination is initially done with the knee extended and then with the knee flexed in order to differentiate between gastrocnaemius (the former) and soleus tightening[3,26,28].

However, there is ample evidence in literature that goniometer based measurements for ankle joint movement are not reliable[29,30,31,32]. Although hand-held goniometers have introduced quantification[33] they have major drawbacks in measuring ROM; goniometric reliability is unproven with reliability studies often having major flaws in design or analysis[34]. In fact, goniometry has been shown to be unreliable for rearfoot assessment[35,36] and the responsiveness of ankle range of motion measurements is uncertain[30].

These problems with reliability have spurred the design of a number of devices and procedures aimed at measuring ankle dorsiflexion. These include, among others:

The Equinometer [37,38]
The Mechanical Equinometer [39]
The Biplane Goniometer [40]
The Iowa Ankle Device [41]
The Lunge Test [42]

4. CONCLUSION

There is still a paucity of information in quantifying Ankle Joint dorsiflexion. An inappropriate measurement using an in appropriate technique could have important repercussions. Wrong techniques for measurement and the use of poorly-validated instruments may provide a mis-diagnosis from which wrong treatment modalities could ensue.

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