What's Afoot

A Study on Ankle Equinus

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The concept of ankle equinus has been well established in Podiatric biomechanics since it was described by Root, Orien and Weed[1]. They described the need for 10 degrees of ankle joint dorsiflexion during gait to allow for normal function. Ankle equinus is deemed to be present if there is less than 10 degrees of ankle joint dorsiflexion available with the subtalar joint in its neutral position. If this motion is absent then compensatory motion occurs.

The aim of this paper is to briefly describe normal ankle joint motion, the methods of compensation, assessment of ankle joint motion and management.

Normal function

Ankle joint motion primarily occurs in the sagittal plane although, due to the orientation of the joint axis, motion does occur in the other planes. Perry[2] has described the pivotal role of the foot during walking in the sagittal plane and has divided the stance phase of gait into three rocker phases.

1) Heel rocker: This phase occurs from heel contact to foot flat. As this represents the period during which weight is accepted by the stance limb, Perry describes this as the loading response. At foot flat the ankle will be slightly plantarflexed.

2) Ankle rocker: Once foot flat has been achieved, the stance limb then pivots over the weightbearing foot, thus the ankle moves from a plantarflexed position to a dorsiflexed position.

3) Metatarsal rocker: Once the heel begins to lift, the body then pivots about the metatarso-phalangeal joints (MTPJ). Initially, the ankle joint remains in the dorsiflexed position attained at the latter part of midstance. At this stage, the knee should be almost fully extended with the hip extended approximately 10-20 degrees. However, as soon as the swing limb achieves heel strike, the ankle on the stance limb plantarflexes, which requires MTPJ dorsiflexion, and the knee and hip begin to flex in preparation for swing.

Some controversy exists as to the position of the heel in the frontal plane during the stance phase of gait. There is increasing evidence that the subtalar joint remains pronated throughout the period of stance that the heel is in contact with the ground[3,4].

Compensation

Clearly, ankle equinus is a functional limitation in calf muscle flexibility. As a result, the effects generally occur during the ankle rocker phase of gait, preventing the normal pivotal motion. There are several methods by which compensation for this reduction occurs :

1) Subtalar joint pronation: As subtalar joint pronation has dorsiflexion as a component, this compensatory motion is often observed. Although there is evidence that the subtalar joint remains pronated, this compensatory force may increase the degree of pronation, cause midtarsal collapse, prevent adequate MTPJ dorsiflexion during the forefoot rocker or maintain pronation following heel lift. This is often the cause of the abductory twist (a medial 'flick'of the heel) observed immediately after heel lift. Flexor stabilisation may be evident at the toes (increased plantarflexion against the ground) in an attempt to stabilise the foot.

2) Extensor substitution: Increased activity of the extensor tendons can be observed, especially during swing in an attempt to dorsiflex the foot.

3) Lateral compensation: The foot is able to dorsiflex at the calcaneo-cuboid and 4th/5th metatarso-cuboid articulations. Therefore, increased motion may be observed at these sites and is often the cause of lateral foot pain and/or cuboid dysfunction.

4) Early heel lift: If there is insufficient pronation available, then the heel will unweight earlier during stance.

5) Genu recurvatum: As the leg attempts to progress over the foot, hyperextension at the knee may occur.

The net result of these compensations may not be observed by frontal plane calcaneal eversion, especially if there is reduced subtalar joint motion. However, the effect on sagittal plane function may be more marked. Often, reduced ankle joint motion, early knee joint flexion and reduced hip joint extension are observed. This results in a slower gait with shorter strides.

Methods of assessment

The most widely utilised method is to measure the angle of the lateral aspect of the foot in relation to the leg, with the subtalar joint held in neutral and the ankle joint maximally dorsiflexed. Care should be taken to prevent subtalar joint pronation and thus compensatory motion. The test can be repeated with the knee flexed to 90 degrees to assess the difference between soleus and gastrocnemius function. Some discrepancy can occur between examiners depending on the degree of force exerted by the examiner.

In addition, care should be taken in observing the lateral aspect of the foot. Some feet demonstrate increased dorsiflexion at the lateral aspect of the foot around the articulations of the cuboid. This results in the forefoot dorsiflexing on the rearfoot. In these cases, the angle of the heel to leg should be used rather than the whole of the lateral aspect of the foot.

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Similarly, some patients demonstrate a forefoot equinus or plantarflexed lateral column. In these cases, the forefoot is relatively plantarflexed on the rearfoot. Whilst the whole of the lateral aspect of the foot can still be used to gauge the overall effect on ankle joint dorsiflexion, the degree of plantarflexion should be noted as this will remain even if adequate calf muscle flexibility is achieved.

An alternative method of assessing function is to use an angled board set at pre-determined angles. The ADEAS is one example which has graduations at 3 degree intervals ranging from 3-21 degrees. The patient stands on the board, with their feet parallel with the edges. If adequate flexibility is available at the set angle, the patient is able to stand upright. If inadequate flexibility is available there will either be an increased lordosis in the lower back or the patient will have to lean forward.

The author has found that patients able to stand upright on a 15 degree slope have adequate flexibility. This angle is slightly higher than that required for normal function as some pronation does occur during the test. This test has the advantage of standardising the force exerted to body weight. Although soleus flexibility is directly tested in this manner, getting the patient to flex their knee whilst standing on the slope can give an indication as to the increased motion available.

It should be noted that hamstring flexibility should also be assessed as this will have an effect on knee function and thus gastrocnemius function.

Management

Clearly, the optimum aim is to regain adequate flexibility. The principle method is by appropriate flexibility exercises. These can be performed by leaning against a wall but the foot should be held around the neutral position (usually by inverting the feet) to reduce pronation. Repeating the exercise with the knee flexed will stretch soleus.

The author has found the use of a stretching board to be the most effective method of increasing flexibility. The patient stands on the highest angle at which they can stand upright until it becomes slightly uncomfortable, however short the period. This is repeated twice a day until they can stand on the slope for 4 minutes comfortably. The slope is then raised to the next level and the process begins again.

Orthoses are not contra-indicated in the presence of ankle equinus but the degree of control utilised may need to be reduced. It should be remembered that a three quarter length device will automatically act as a heel lift due to the thickness of the material. Furthermore, the heel height of the shoe will further reduce the problem. It may be that the combination of these two is sufficient to negate the effect of the equinus.

In addition, the degree of available subtalar joint compensation is important when deciding the degree for control. For example, let us assume one patient has a neutral calcaneal stance position (NCSP) of 10 degrees inverted and that this is fully compensated so that the heel is perpendicular to the ground in the relaxed stance position (RCSP). An orthosis with 4 degrees of medial rearfoot control will only control a small proportion of the pronation. Thus there is still motion available to compensate for a degree of equinus.

Let us now assume a similar patient has a NCSP of 4 degrees inverted with an RCSP of 0 degrees. The same device will control all of the rearfoot motion and thus reduce the ability of the foot to compensate for the equinus. Clearly, the effects of the device on the latter patient will be greater than the former patient.

Heel raises are useful in counteracting the effect of an equinus but it should be stressed to the patient that greater stretching may be necessary to prevent further shortening. A heel raise is important in cases of forefoot equinus as flexibility exercises will not reduce this deformity.

In cases where increased motion is not achieved and the foot has attained a compensated position, attempting to control the foot position is often not appropriate. In these cases, a pronated orthosis to support the current position, in attempt to prevent further collapse of the foot, is the best option.

It is important to consider the effect any orthosis has on the sagittal plane function of the foot and leg. Once the device has been issued, this function should be reassessed. The aim is to facilitate the ankle and metatarsal rockers. This will allow knee and hip extension during the former, followed by hip and knee flexion and ankle joint plantarflexion during the latter.

Conclusions

Ankle Equinus is a common entity that can have a profound effect on locomotion. An understanding of these effects, their mechanisms and the methods utilised to manage the condition can greatly improve treatment outcomes. Furthermore, it may prevent the prescription of inappropriate devices that often result in patient dissatisfaction.

References:

1 Root M L, Orien W P, Weed J H, Clinical biomechanics: Normal and abnormal function of the foot, Vol. 2. Los Angeles, Clinical Biomechanics Corp., 1977. 2 Perry J, Basic Functions, In: Gait analysis; Normal and pathological function (Ed Perry), Slack Inc, pp 31, 1992. 3 McPoil T, Cornwall M W, Relationship between subtalar joint neutral position and pattern of rearfoot motion during walking, Foot & Ankle, 15(3):141-145, 1994. 4 Pierrynowski M R, Smith S B, Rearfoot inversion/eversion during gait relative to the subtalar joint neutral position, Foot & Ankle, 17(7):406-412, 1996.