What's Afoot

Rearfoot Varus

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Definition

There is a misnomer in the use of the Latin words Varus and Valgus. The meaning of varus and valgus are often reversed, so that genu varum is bow leg not knock knee[1]. It denotes a deformity in which the angulation of one part is toward the midline of the body. Varus deformities occur in the frontal plane. The denomination implies the inversion of one segment relative to an adjoining one.

Rearfoot Varus (RFV) is defined as the inversion of the sagittal bisection of the posterior surface of the calcaneus relative to a perfectly horizontal supporting surface.

In order to clinically diagnose biomechanical foot deformities, the lower limb must be placed in a certain standard position where the knee joint is fully extended, the subtalar joint (STJ) is in the neutral position and the midtarsal joint (MTJ) is fully pronated. This position will be referred to as the Standard Lower Limb Position (SLLP).

RFV may constitute a subtalar component, a tibial component or both. The subtalar component can be diagnosed during open kinetic chain motion (Non weight bearing examination) and SLLP. This will reveal that the sagittal bisection of the posterior surface of the calcaneus is inverted relative to the sagittal bisection of the distal third of the back of the leg. Normally, in a 3 months old foetus, the supination-varus angle of the calcaneus is 36.8 degrees. This angle decreases gradually; by the 9th intrauterine month, it is 26.3 degrees and in the adult, it measures 3.5 degrees2. Failure of this calcaneal rotation may result from developmental defects affecting the calcaneus, the talus or the tibial plateau and is responsible for the subtalar component of RFV.

The tibial component can be diagnosed during closed kinetic chain motion (Weight bearing examination) and SLLP. This will reveal that the sagittal bisection of the posterior surface of the calcaneus is inverted relative to a perfectly horizontal supporting surface with this bisection remaining in alignment with the sagittal bisection of the distal third of the back of the leg. Such a deformity may result from tibial varum which may be caused by diseases affecting the shape of the tibia such as rickets, Blounts disease or genu varum. Indeed, both components may coexist, each contributing few degrees of calcaneal inversion to the overall deformity.

The mechanics

A compensatory mechanism is a change in the structure, function or position of one part of the body in response to a change in the structure, function or position of another part.

In response to the frontal plane deformity of RFV, the STJ attempts to pronate as a compensatory mechanism. This pronation is aiming at the correction of this deformity by everting the calcaneus. However, STJ pronation is a triplane motion. If the STJ is able to pronate, inevitably abduction and dorsiflexion will occur in the transverse and sagittal planes respectively with the calcaneal eversion.

With inversion of the calcaneus to the supporting surface, the medial side of the foot will not be able to take part in weight bearing unless the calcaneus everts. The degree of calcaneal eversion depends on the degree of STJ compensatory pronation available. In other words, if no STJ pronation is available, the calcaneus will remain inverted, the medial side of the foot will remain non weight bearing and the condition is labelled Uncompensated rearfoot varus

When the STJ is able to pronate to allow a sufficient degree of calcaneal eversion to bring the medial side of the foot plantargrade, the condition is labelled Fully Compensated Rearfoot Varus.

An intermediate situation arises when the degree of STJ pronation is limited, allowing a lesser degree of calcaneal eversion than required for the foot to become plantargrade. Under these circumstances, the medial side of the foot approaches the supporting surface without becoming fully weight bearing and the condition is labelled Partially compensated rearfoot varus. Even though the frontal plane component of STJ pronation is required for the correction of the deformity, the accompanying transverse and sagittal plane components are not required and are indeed responsible for much of the associated pathological features of fully and partially compensated RFV. The pathological features of uncompensated RFV on the other hand, are caused by the lack of this compensation.

The pathological features of the various types of RFV are better understood when discussed with the pathomechanics of the compensatory mechanisms associated with this deformity.

Conditions caused by RFV

(Pathological features of RFV)

Fully compensated RFV:

This deformity is the least likely of the three types of RFV to develop any significant pathology as the opportunity for resupination before propulsion is available. The heel will be seen to be vertical to the supporting surface in relaxed calcaneal stance (RCS) with the plantar arch showing a low profile and the medial side of the foot plantargrade. As a result of the abnormal compensatory pronation, the forefoot may become hypermobile. At the forefoot loading stage of the stance phase of gait, the first ray will dorsiflex and invert and the fifth ray will dorsiflex and evert. The plantar aspects of 2-4 metatarsal heads will be subjected to more ground reaction forces with hyperkeratotic lesions over these areas. The hypermobile first ray relative to the more stable first cuneiform may lead to the development of a dorsal exostosis over this articulation.The shearing stresses acting upon the hypermobile forefoot may lead to metatarsalgia and may contribute to the development of a Mortons interdigital neuroma. There will be no lesions over the lateral side of the plantar aspect of the foot. Rapid eversion on heel contact may lead to the formation of Haglands deformity and retrocalcaneal bursitis as a result of abnormal shearing forces of the calcaneus relative to the heel counter of the footwear.

Partially compensated RFV:

Here, the amount of STJ pronation available is not sufficient to bring the medial side of the foot plantargrade. The calcaneus is able to evert only to a lesser extent and weight bearing remains predominantly along the lateral side of the foot. This may lead to hyperkeratosis and heloma durum over the plantar aspect of the lateral metatarsal heads.

The first ray, still non weight bearing, plantarflexes to bring the medial column down to the supporting surface. This may cause a dorsomedial exostosis of the first metatarsophalangeal joint and may ultimately lead to hallux rigidus.

The long-standing retrograde sagittal forces acting upon the digits may lead to clawing of the toes and an adductovarus deformity of the fourth and fifth toes. Consequently, a heloma mole may develop in the fourth interdigital cleft.

Haglands deformity and retrocalcaneal bursitis may also develop (see fully compensated RFV).

Uncompensated RFV:

This type of RFV is rarely developmental. It usually occur as a result of trauma or arthritis affecting the STJ. No STJ pronation is available and the medial side of the foot is unable to make contact with or even approach the supporting surface.

The heel will remain inverted in relaxed calcaneal stance, which may predispose to inversion sprain of the ankle and hyperkeratosis over the lateral border of the heel. In an attempt to stabilise the foot, the first ray plantarflexes to make ground contact, giving the foot a high arch profile. Alternatively, hallux flexus progressing later into a hallux rigidus may develop. As a result of the lack of STJ pronation, the foot assumes a rigid posture with the MTJ remaining locked from the beginning of the stance phase of gait. This diminishes the shock absorbing function of the foot and problems affecting the knee, the hip and the lower back may arise. The lack of STJ pronation also causes an abductory twist to assist in the transfer of weight from the lateral to the medial side of the foot. This may cause hyperkeratosis over the medial aspect of the hallux and may also cause a heloma durum over the plantar aspect of the fifth metatarsal head.

Treatment

The average neutral position of the heel is 2-3 degrees inverted to the supporting surface. Such a degree of RFV is not associated with abnormal compensation and therefore, does not require treatment. The deformity should be treated only when the RFV angle is greater than 4-5 degrees in adults and 6-8 degrees in children.3

Structural changes in a flat foot deformity were demonstrated in response to the use of foot orthosis in children.[4,5,6] No evidence of such changes was demonstrated in adults. Therefore, in children, the objective of treatment is to encourage the STJ to function around its neutral position and at the same time, allow some talar valgus torsion and calcaneal eversion so that the deformity is given a chance to gradually decrease with age.

In the adult, the aim is to achieve the best possible control when the deformity is still mobile. The uncompensated variety , on the other hand, needs to be accommodated, allowing the redistribution of ground reaction forces for a more uniform weight bearing.

The term ‘orthosis’ comes from Greek for Making straight[1]. There are many different types of foot orthosis. These may, fall into two general categories; biomechanical (functional) or accommodative.

The role of biomechanical orthosis is to control abnormal and potentially harmful movement of STJ and MTJ. Such an orthotic device should meet the following criteria; be comfortable, conform to the contours of the foot, keep the STJ as close to its neutral position as is practical, allow a normal sequence of STJ and MTJ motion during the stance phase of gait and be adjustable according to the patients response[7].

Studies employing motion analysis demonstrated the effectiveness of orthotics on controlling excessive pronation. All these studies displayed a significant reduction in the degree of pronation in the stance phase of gait during walking,[8,9,10,11,12,13,14,15] as well as running[16].

Control of excessive STJ pronation can be achieved by employing a medial rearfoot post or a combination of a medial rearfoot and forefoot post. A post is a wedge on the medial or lateral side of an orthotic device, designed to support or control movement, primarily in the frontal plane[17].

It has been demonstrated that a combined forefoot and rearfoot posting reduced motion of the calcaneus in the frontal plane the greatest.[12] Root et al[18] believed that a rearfoot post should control but not eliminate STJ pronation. They recommended a minimum of 4 degrees normal pronation to be allowed after heel strike to maintain shock absorption and transverse rotation of the lower extremity.

There are conflicting reports relating the use of orthotics to rearfoot movement. Some studies have shown that rearfoot varus posts significantly decrease maximum eversion.[12,19,20,21] Bates et al[22] found no significant change in maximum eversion. Brown et al[13] found no significant difference between prescription orthotics and off the shelf shoe inserts on maximum calcaneal eversion.

It is recommended therefore, that the type and the degree of posting required to control excessive STJ pronation should depend on thorough assessment, clinical experience and, where possible, the patients response to a trial of temporary posting.

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