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Treatment and Causes of Non-Neurological Cavovarus Feet in Skeletally Immature Patients

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Abstract

Cavus foot defined as a foot highly arched, is not infrequent in childhood, and is an asymptomatic normal foot variant. However, certain forms of cavus may be related to a neurological lesion and its secondary muscle imbalance and be symptomatic. Because of the multiple causes and different presentation, an understanding of the underlying muscle imbalance in the cavovarus foot is extremely important to guide treatment. One of the most important challenges in treating cavovarus foot is to elucidate the responsible cause for the deformity. The aim of the following review is to point the main causes of cavovarus foot, and to guide the best treatment for the deformity in the skeletaly imature patients.

Keywords: Cavovarus foot; Foot deformity; Neurological lesion; Skeletal dysplasia syndromes

Introduction

Cavovarus foot denotes the presence of a three-dimensional deformity of the foot, but it is much more a descriptive feature than a diagnosis. Although Pes Cavovarus (PCV) may be idiopathic in origin, in most cases, there is an underlying neurological condition. Therefore, one of the most important challenges is to elucidate the responsible cause for the deformity. Finding the correct diagnosis can be difficult, but the search for the cause should never be ignored. Firstly, because the nature of the condition may determine the quality and life expectancy of the patient, and secondly, because our management plan will largely depend on the subsequent diagnosis [1].

Population-based studies suggest the prevalence of the cavus feet is approximately 10 to 20%, some of which represent a normal variant. Around 66% of cavovarus feet are the result of subtle neurologic diseases and conditions that may not become clinically evident until later in life.

Although the number of neurologic conditions that may lead to cavus foot is extensive, the common factor is muscle imbalance that disrupts the synergy between the intrinsic and extrinsic muscles. Non-neurological causes are less common; they include skeletal dysplasia syndromes, birth defects, progression of congenital idiopathic clubfoot, tarsal coalition and trauma. Idiopathic pes cavovarus is exceedingly rare (Table 1).

S.no	Non-neurological causes
1	Muscular dystrophies
2	Post-traumatic
3	Secondary to vascular ischemia and compartmental syndrome
4	Secondary to clubfoot
5	Associated to syndromes
6	Idiopathic

Table 1: Non-neurological causes of cavovarus feet.

Isolated injuries to nerves, muscles, and tendons can result in cavovarus foot and may provide insight into how specific muscle imbalance can cause a foot deformity. Cavus deformity may occur after an injection injury to the sciatic nerve, after fibrous contracture of the deep posterior compartment resulting from vascular damage, can be a missed deep compartment syndrome, or a severe muscle laceration, or a combination of these mechanisms. Cavovarus deformity has also been associated with clubfoot or residual clubfoot deformity in 22% of children [2].

An understanding of the underlying muscle imbalance in the cavovarus foot is extremely important to guide treatment. Flexible cavovarus feet in children and adolescents can be very challenging, especially those that get worse with growth. A careful history and physical examination are primordium for determining the best treatment strategy, but an infinity options are available. Specific treatment strategies must be individualized and any bony correction has to be in association with a muscle-balancing procedure [3].

Treating the deformity in the immature skeleton has the advantage of bone remodeling when muscle balance is achieved, but with the potential for growth, undercorrections may lead to recurrence of the deformities. Excessive pressure on the head of the first metatarsal or base of the fifth metatarsal during weight bearing may cause pain, usually children tolerate it well but it can become disabling in adults. For these reasons, non-neurological cases should be treated early.

Ankle instability may manifest as recurrent tibiotarsal or subtalar sprains (hindfoot varus and weakness of the peroneus brevis muscle). Persistence of these abnormalities may result in chronic ankle instability, which has a severe impact on functional outcomes and progression of the deformity and cause pain and disability in adulthood.

Literature Review

Physical examination

Clinical examination should include a shoeless assessment of the patient's gait. In younger children, the physical examination often ends up being complicated and the help of parents is essential. As most cases have neurological causes, the clinical examination needs to include a thorough neurological evaluation and a complete clinical history in search of congenital malformations that could cause such deformities [4].

The presence of a foot drop or an extensor recruitment to compensate for weak dorsiflexion should be noted, and again, in the youngest it might be quite challenging. Abnormal heel and tandem walking may be an early sign of alert. When a calcaneocavus foot is present a pegleg gait may appear as a result of the poor push-off. The Trendelenburg test should be included in the dynamic assessment.

It is important to check side involvement: Uni or bilateral, assess the hindfoot position and differentiate between the type of cavus deformity, as well as assess the flexibility of the hindfoot, using the Coleman block test. In the Coleman test the patient is asked to stand with the heel and lateral border of the foot over a 1-inch- high block while the medial metatarsals contact the floor. When the hindfoot is flexible the heel will return to a neutral or valgus position [5].

The clinical evaluation must identificate of the apex of the deformity, and surch for other foot anomalies: Assessing associated toes deformities in example. Assessing where calosities are present, usually at the head of the first and fifth and base of the fifth metatarsals, and lateral side of the hindfoot, assess the flexibility of the foot joints and if a manual correction of the deformities is possible. Assessing ankle mobility, especially in the older ones and adolescents and also assess the Achilles length.

A global examination should include: A detailed spine examination looking for hairy patches, dimples or structural deformities. Hip assessment including motion (to exclude hip dysplasia). Finally, the hands should be evaluated for wasting of the intrinsic muscles (thinking on Charcot-Marie-Tooth). A basic neurological examination should include muscle power, with good attention to the evertors, tendon reflexes, and a sensory examination [6].

Radiographic evaluation

The standard measurements for foot deformity should include:

- Meary angle (normal value: 0º) is the longitudinal axis of the first metatarsal (1MTT) and the talus normally forms a straight line. When a cavus foot is present, the lines intersect at the apex of the deformity (normally at the dorsal aspect of the first cuneiform body). Increase is indicative of 1MTT plantar flexion.
- Calcaneal pitch is the angle formed by a line along the plantar surface of the os calcis and a line that goes through the floor. The normal value is <25º. A calcaneal pitch >30º is indicative of posterior cavus (calcaneocavus).
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- AP-talus-1MTT angle (12 abduction, -10 adduction) in a normal foot the line formed by the longitudinal axis of the talus and the 1MTT are parallel or intersect at the body or neck of the talus. In malalignment the axes intersect at the level of talonavicular or the head of the talus. The 1MTT is always adducted in relation to the talus.

Managing non-neurological cavovarus feet

There is a lack of consensus about what constitutes the ideal treatment for cavovarus feet, which is reflected by the wide variation in treatment applied in different centres [7]. There are numerous factors that may explain this disparity:

- The wide aetiological spectrum responsible for this deformity;
- The variable severity of involvement even in patients sharing a common mutation and finally, and even more importantly,
- The paucity of long- term reports describing the various techniques.

Another factor rarely discussed in the literature is that of the differences in treatment between children and adults. Many studies report adults and children together, making no stratification of the results according to age. The importance of segregating these populations lies in the fact that muscle imbalance in children occurs in a growing skeleton, therefore the uneven forces will favour a skewed bone growth and an abnormal development of the bony structures. Non neurological cases should be treated as soon as possible, seeking muscle balance so that the cartilaginous model ossifies in a better position [8].

Conservative treatment has been recommended in the non-progressive flexible cavovarus foot, as insoles supporting the lateral side of the foot or with metatarsal bars, unloading the areas of excessive pressure [9].

The objectives of a successful treatment are to achieve a painless, plantigrade, mobile foot.

The principles of treatment of pes cavovarus laid down by Mosca in 200110 are still applicable:

- Correct all of the segmental deformities while preserving motion,
- Secondly balance the remaining forces
- Leave reasonable treatment options available for possible recurrence of deformity and pain [10].

Conclusion

In summary, the causes of cavovarus feet are numerous and treatments must be selected according to the causes. The main causes of cavovarus feet are attributed to neurological conditions. Non-neurological causes in skeletally immature patients include congenital clubfeet, tarsal coalition or post traumatic conditions.

Unlike neurological cases, treatment must be early applied and usually presents good results with muscle balance and corrective osteotomies. Knowing the original cause of the deformity leads to a more accurate treatment with better results.

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