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THE PES CAVUS, SCOPING REVIEW

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SUMMARY

Introduction: *Pes cavus is a deformity characterized by cavus (elevation of the longitudinal plantar arch of the foot), plantar flexion of the first radius, forefoot pronation and valgus, rearfoot varus and forefoot adduction. Muscle strength imbalance is the most notable origin of such deformity.*
Objective: *to detail the current information related to pes cavus, concept, manifestations, etiology, epidemiology, presentation, anatomy, pathophysiology, diagnosis, complementary tests, treatment, complications and prognosis.*
Methodology: *a total of 25 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 16 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: pes cavus, cavo-varus, foot deformity, foot muscle strength imbalance.*
Results: *The pathology has a strong underlying association with neurological conditions. It usually occurs in adolescence or early adulthood, although it can occur in any age group. In diabetic patients there is a prevalence of 25%. Meary's line is a line between the talus and the first metatarsal, normally it has a value of 0, in pes cavus it increases, being mild from 5 to 10 degrees and severe above 20.*
Conclusions: *It is important to understand that early identification and intervention are essential to prevent progression from flexible and correctable pes cavus to rigid pes cavus. Therefore, it is essential to know the basis of the pathology, both anatomical, etiological and pathophysiological, as well as its association with other entities or pathologies of the nervous system. In addition, it is necessary to know how to perform an adequate clinical evaluation together with a physical examination and adequate complementary examinations to determine the correct diagnosis and choose the type of treatment to be performed. It is evident that cavovarus foot deformities in adults are frequently approached by means of joint preservation osteotomies and complementary soft tissue procedures, however, currently there are several alternative surgical options available to achieve good results, being the usual first approach to the fixed forefoot deformity and if necessary, to perform a valgus osteotomy. It is recommended that bony correction be performed in conjunction with a soft tissue balancing procedure, in addition to residual toe deformities being restored last. The*

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forms of treatment should be individualized, the choice of the procedure to be used will depend on the deformity and the experience of the surgeon, adapted to the specific clinical picture of each patient.

KEY WORDS: *pes cavus, metatarsalgia, plantar arch, muscular imbalance.*

INTRODUCTION

Pes cavus is an orthopedic disorder that occurs in both children and adults. Pes cavus and pes cavovarus are usually used interchangeably because the most common manifestation of pes cavus is the cavovarus presentation. Pes cavus is a deformity characterized by cavus (elevation of the longitudinal plantar arch of the foot), plantar flexion of the first radius, forefoot pronation and valgus, rearfoot varus and forefoot adduction. Pes cavus is commonly a manifestation of an underlying neurological pathology, however there is a subset of individuals in whom a more subtle form of pes cavus may be present without an underlying pathological process(1-3).

Cavovarus foot is a common form of foot deformity in children, which is clinically distinguished by an abnormal increase in the longitudinal arch of the foot and may be complicated by pronation and varus of the forefoot, varus of the rearfoot, contracture of the Achilles tendon or gallo- deformity up to the toe. Muscle strength imbalance is the most notable origin of such deformity. Several diseases can generate an imbalance of muscle strength, such as tethered cord syndrome, Charcot-Marie-Tooth disease, cerebral palsy and trauma. Today, there are several surgical treatments available for cavovarus foot. For older children, priority should be given to midfoot osteotomy and fusion. Because complications such as abnormal foot length, foot stiffness and abnormal gait may develop postoperatively, it is important to preserve the joints and restore the deformity as much as possible. Proper soft tissue release and muscle balance are essential to improve the deformity and prevent its recurrence postoperatively(4,5).

METHODOLOGY

A total of 25 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 16 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: pes cavus, cavo-varus, foot deformity, foot muscle strength imbalance.

The choice of bibliography exposes elements related to pes cavus, concept, manifestations, etiology, epidemiology, presentation, anatomy, pathophysiology, diagnosis, complementary examinations, treatment, complications and prognosis.

DEVELOPMENT

Concept

The pes cavus could be defined as the elevation of the longitudinal arch of the foot, that is, a high arched foot, although the concepts vary among authors(6).

Primary manifestation

The main manifestation is usually due to pathological malposition of the foot, as a result of muscular imbalances. The pathology presents a great underlying association of neurological conditions, however, it can occur without other neurological disorders, i.e. only the imbalance between the muscular forces of the intrinsic and extrinsic musculature of the foot(6).

Presentation

The pathology usually presents in adolescence or early adulthood, however it can occur in any age group. Cavovarus deformity can be classified according to the severity of the misalignment, from a subtle and flexible cavovarus deformity to a severe and fixed cavovarus foot deformity(6,7).

Figure 1. Rigid cavus foot with severe plantarflexed forefoot and claw toes.

Source: Maynou C, Szymanski C, Thiounn A. The adult pes cavus(7).

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Etiology

Pes cavus is seen in both adult and pediatric populations. When known to be bilateral, it is usually hereditary or congenital in origin. A unilateral presentation is more typical of post-traumatic conditions(8).

The most common origin of pes cavus is hereditary motor and sensory neuropathies (HMSN), the most common subtype being Charcot-Marie-Tooth (CMT) disease. CMT is a progressive degeneration of the myelin of peripheral nerves with reduced motor nerve conduction. Deformities often worsen and surgical treatment is usually the treatment of choice for these individuals to prevent progression to a fixed deformity(7).

Some authors report that a unilateral cavus presentation requires an MRI of the brain and spinal cord to exclude treatable progressive lesions such as a brain tumor or, during growth, an anchored spinal cord(9,10).

- Neurological disorders: hereditary motor and sensory neuropathies (HMSN), post-stroke symptoms, Roussy-Levy syndrome, anterior horn disease, cerebral palsy, polyneuritic syndromes, Parkinson's disease, Huntington's chorea, spinal cord lesions, myelomeningocele, Friedreich's ataxia, amyotrophic lateral sclerosis, poliomyelitis, leprosy, Pierre-Marie heredotaxia, Stumpell-Lorrain disease, among others.
- Traumatic: compartment syndrome, vascular injuries, malunion of the talar neck, knee dislocation, scar tissue, peroneal nerve injury, burns, hindfoot instability, distal tibia fractures, malunion of the calcaneus.
- Post-traumatic bone deformities, ligament imbalance or instability usually lead to post-traumatic deformity.
- Unmanaged or insufficiently managed clubfoot.
- Idiopathic causes include rheumatoid arthritis, ankle osteoarthritis, diabetic foot syndrome, plantar fibromatosis, subtalar varus joint axis and tarsal coalition. Subtle pes cavus is usually classified within the idiopathic group(6).

Epidemiology

According to the literature, the true incidence of the pathology is unknown, due to a poor definition, and it also varies according to location, health system and the definition of cavus used. In diabetic patients there is a prevalence of 25%. In addition, studies indicate that there is no significant difference between sexes(6).

Anatomy

When presenting with a weak tibialis anterior, the intrinsic foot muscles and peroneus brevis are dominated by a stronger peroneus longus and tibialis posterior. Subsequently these muscles can weaken and remain in a state of contracture, producing the same effect. The insertion of the peroneus longus into the metatarsals and medial wedge results in plantar flexion of the first radius and pronation of the forefoot. Varus deformity will eventually result as an attempt to obtain a plantigrade foot by compensation through the subtalar joint, prolonged compensation can lead to a progressive and fixed deformity over time. A high longitudinal plantar arch, varus heel position, equinus forefoot and pronation of the first radius are characteristic of a cavovarus deformity(6,8,11,12).

Pathophysiology

Can be divided according to the region involved, usually as follows:

1) forefoot: by unopposed contraction of the peroneus longus and the resulting plantar flexion of the first radius.
2) rearfoot: due to varus malalignment of the rearfoot, as a compensatory pattern(6).

Diagnosis

Diagnosis is made with a combination of history, physical examination and imaging, the most frequent symptom being foot pain. Something important to take into account is the differentiation of forefoot or rearfoot deformity, in addition to performing the Coleman's block test to define whether the deformity is rigid or flexible. The Coleman block test is performed by placing a block of approximately 1 inch (or 2.5 cm) or a book under the lateral side of the forefoot and heel. The head of the first metatarsal should hang off the edge of the block, thus removing its effects on the tripod. Subsequently, the examiner should evaluate the hindfoot to determine if the removal of the deforming effects of the first metatarsal has allowed the hindfoot to repair from varus to valgus. If the hindfoot varus is not repaired, the deformity is rigid and fixed, and this has different surgical implications than a flexible deformity. If the locking test reforms the hindfoot valgus, then the deformity is flexible and forefoot-driven. The goal of the clinical examination is to detect subtle cavus or cavovarus deformity, assess the severity and type of deformity, as well as differentiate between idiopathic, other secondary etiologies of cavus foot deformity, as well as assess for possible related anomalies. The clinical examination should begin with a gait analysis. The neurological examination sometimes reveals peripheral neuropathy or central nervous system etiology for the foot deformity(6,13).

Complementary Examinations

The initial complementary examinations are radiographs. Usually an anteroposterior and a lateral radiograph with load is requested. The relative position of the inferior aspect of the medial wedge and the base of the fifth metatarsal can be evidenced in the lateral radiograph. The base of the fifth metatarsal is closer to the ground, the foot is in cavus. There are multiple angles that can be assessed to know the degree of foot deformity for both pes cavus and valgus foot. The Meary line is a line between the talus and the first metatarsal, normally it has a value of 0, in the pes cavus it increases, being mild from 5 to 10 degrees and severe superior to 20. This is a measurement between the longitudinal axis of the calcaneus and the first metatarsal. Values in normal feet are generally less than 45 degrees. In patients with cavus foot deformities, the angle is usually greater than 90 degrees(6,13,14).

Requested foot radiographs should include at least these three views:

- Lateral view of the weight-bearing ankle and foot allows demonstration and measurement of the cavus.
- Frontal view of the ankle (Meary's view or Salzman's view) demonstrates frontal rearfoot deformity.

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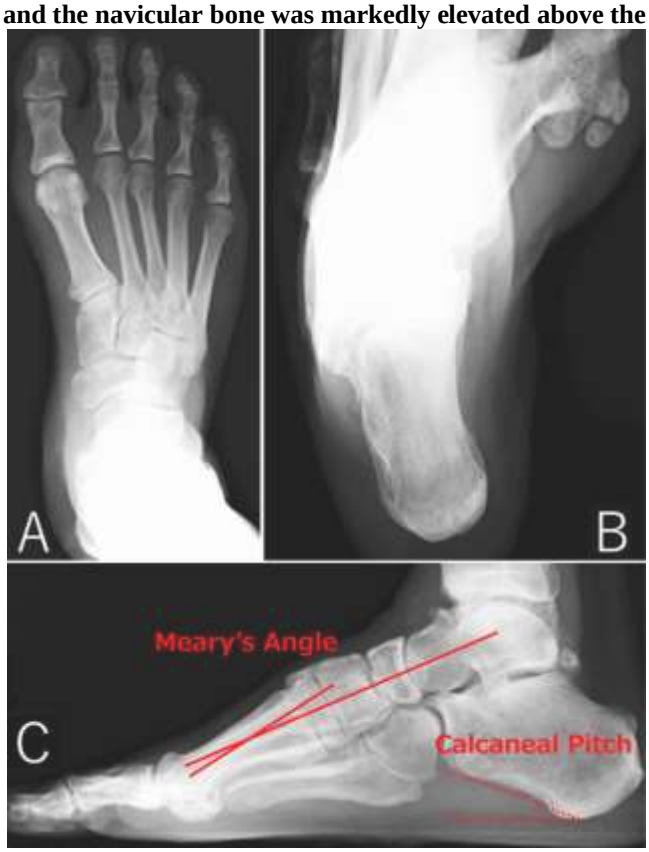
- Dorsoplantar view of the forefoot shows the adduction of the forefoot and the opening of the metatarsal plate(7).

Then on plain radiographs, forefoot driven deformity can be assessed using Meary's angle and rearfoot driven deformity can be measured by calcaneal pitch. Computed tomography and magnetic resonance imaging allow assessment of tarsal coalitions and soft tissue pathologies, respectively(13).

Figure 2. Radiograph showing incidences in a pre-surgical pes cavus. The Meary angle was 13°, the calcaneal inclination was 23° and the navicular bone was markedly elevated above the ground.



Source: Kisamori K, Kimura T, Saito M, Kubota M. Lateralizing osteotomy of the calcaneus and dorsiflexion osteotomy of the first metatarsal for cavovarus foot and peroneal sheath release with peroneus brevis repair for peroneal tendinopathy in chronic instability and ankle sprain(15).

Conservative Treatment

Conservative treatment can be used in deformities and mild symptoms with relative success with custom orthoses, with the aim of realigning the rearfoot and unloading the lateral part of the foot. There are studies where botulinum toxin A was used in children with CMT, demonstrating that it was a safe and well-tolerated procedure, however, without significant decrease in the progression of the cavus deformity. Strengthening and stretching are reasonable short-term options.

It is important to know that usually in HMSN, the pes cavus will continue to progress and the deformity will become fixed and rigid without surgical correction(6).

Therefore, standard non-surgical interventions include activity modification, anti-inflammatory medications, simple accommodative shoes and custom orthoses(7).

Surgical Treatment

There is a wide range of techniques that could be performed for the correction of the pathology among these we have tendon transfers, tendon lengthening, calcaneal osteotomies, osteotomies of the neck of the talus, osteotomies of dorsiflexion of the first radius, osteotomies of the midfoot and arthrodesis. The choice of the procedure to be used will depend on the deformity and the surgeon's experience, adapting to the specific clinical picture of each patient(6).

There are studies showing that calcaneal lateralization osteotomy and dorsiflexion osteotomy of the first metatarsal for cavovarus foot release and peroneal sheath with repair of the peroneus brevis for peroneal tendinopathy in chronic ankle instability and sprain have good results(15).

Also, there are studies on soft tissue release combined with joint preserving osteotomy for the treatment of cavovarus foot deformity in older children, where its efficacy in the treatment of cavovarus foot deformity in this age group has been demonstrated(4).

Joint-conserving surgery is the best alternative in flexible cavovarus foot even in Charcot-Marie-Tooth (CMT) disease

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(peroneal muscular atrophy). Arthrodesis is indicated in severe cavus cavus foot or when degenerative cases are present(7).

Figure 3. Radiographs showing incidences in a post-surgical pes cavus.

Source: Kisamori K, Kimura T, Saito M, Kubota M. Lateralizing osteotomy of the calcaneus and dorsiflexion osteotomy of the first metatarsal for cavovarus foot and peroneal sheath release with peroneus brevis repair for peroneal tendinopathy in chronic ankle instability and sprain(15).

Complications

The literature indicates that delay in diagnosis or prolonged use of braces despite worsening of the deformity may lead to a fixed and rigid deformity, so that salvage surgery such as arthrodesis may be chosen. When the neurology is progressive, no surgical procedure can completely protect against recurrence(6).

Prognosis

This will depend on the severity of the deformity, the underlying etiology and the age at presentation. The deformity usually develops gradually and begins before puberty. In children, the deformity is initially compensated but may become more rigid over time, leading to alterations in bone growth, effects on subsequent bone development and alteration of the shape and morphology of the developing foot(6,16).

CONCLUSIONS

It is important to understand that early identification and intervention are essential to prevent the progression of flexible and correctable pes cavus to rigid pes cavus. Therefore, it is essential to know the basis of the pathology, both anatomical, etiological, pathophysiological, as well as, to know its association with other entities or pathologies of the nervous system. In addition, it is necessary to know how to perform an adequate clinical evaluation together with a physical examination and adequate complementary examinations to determine the correct diagnosis and choose the type of treatment to be performed. It is evident that cavovarus foot deformities in adults are frequently approached by means of joint preservation osteotomies and complementary soft tissue procedures, however, currently there are several alternative surgical options available to achieve good results, being the usual first approach to the fixed forefoot deformity and if necessary, to perform a valgus osteotomy. It is recommended that bony correction be performed in conjunction with a soft tissue balancing procedure, in addition to residual toe deformities being restored last. The forms of treatment should be individualized, the choice of the procedure to be used will depend on the deformity and the experience of the surgeon, adapted to the specific clinical picture of each patient.

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