

# Forefoot Varus (FV) in Children

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**Abstract— Introduction:** Forefoot varus is a disease that occurs from birth and describes a situation in which the child's feet are turned towards its body.

**Purpose:** The purpose of this review is to present the forefoot varus disease in children.

**Methodology:** Extensive review of the recent literature in electronic databases (Pubmed, Google scholar) and journals, with the keywords: child and forefoot varus.

**Results:** Forefoot varus is a disease that describes a situation in which the child's feet are turned inwards. The foot deviates inwardly (varus) and downwards (equinus). The frequency of forefoot varus is estimated at 1-3 per 1000 live births and is more common in boys, and concerns both feet in 40% of the cases.

**Conclusions:** Forefoot varus is a condition that must be diagnosed early to start treatment.

**Index Terms—FV, Hippocrates, equinus**

## I. INTRODUCTION

### Chronology

The forefoot varus (FV) was first mentioned by Hippocrates in 400 B.C.; the latter describes it in detail, both the disease and its treatment, at the same time attributing the disease to the effect of mechanical damage. [1]

In 1820 Montfalcon describes Hippocrates' therapeutic principles, among which the violent restoration effort was absent - the leg came back to normal gradually, with mild manipulations and bandages. Besides Hippocrates' description, reports of the disease exist in Greek mythology, but the frequency of FV in archaeological findings is small. [2]

We know little about FV treatment from Hippocrates' times till the Middle Ages. In the 15<sup>th</sup> century there are reports about the use of special shoes and wooden or metal devices that were applied based on anatomy principles to correct FV. During the middle Ages the treatment of FV and other deformations was a privilege of charlatans and only after the 18th century passed into the hands of medicine. [1]

As far as treatment is concerned, Fallopio (1523-1562) applied both the principle of progressive daily correction and the principle of overcorrection. Cheselend (1688-1752) applied bandages made of materials such as egg and flour, while German Dieffenbach (1792-1847) was the first who applied the plaster cast. During the 18<sup>th</sup> and 19th century Scarpa gives an excellent description of the pathological anatomy of FV and suggests a successful treatment method. [3]

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Surgeon W. J. Little's (1810-1894) contribution to FV treatment was great. Little was suffering from paralytic equinus due to polio and was operated successfully. Since then, he devoted his life to FV patients' treatment and promoted Orthopaedic surgery to such an extent that he was called its father. [2, 3]

In the 20th century, there were both conservative treatment methods and surgical techniques to restore FV. In the field of conservative treatment J. Hiram formulated the basic principles of progressive correction, initially the adduction of the forefoot, then of the supination and finally the equinus by applying plaster casts. In the field of surgery of FV there was remarkable progress in the 20<sup>th</sup> century, especially in soft tissue operations. [4]

## II. FOREFOOT VARUS (FV)

FV is a disease appearing at birth and refers to the angling or inverted position of the bones in the front of the foot in relation to the heel. In an uncompensated forefoot varus deformity, this causes the bones on the inside edge of the foot to sit higher off the ground than the outside of the foot during weight bearing. As for the frequency of FV, it is estimated that it happens in 1-3 out of a 1000 births and is more common in boys, also affecting both feet in 40% of the cases. [5]

FV can be idiopathic, in other words without the presence of another disease but can also appear in syndromes like arthrogryposis or the Larsen syndrome. FV is accompanied by muscle, ligament and bone disorders in the foot. These disorders are not so obvious in children that haven't started walking yet. The angling gradually subsides until the child turns 3 years old, at which stage it is self corrected. However, in case it continues and gets more intense medical help should be sought. [2, 5]

## III. ETIOLOGY

FV is a genes disorder that is more common in boys and is hereditary. However other factors are responsible for it: for instance the lack of amniotic fluid and uterus conditions that reduce its capacity (like congenital abnormalities, twin pregnancy, neoplasms etc). [6]

Additionally it can be caused by neuromuscular damages, like myelodysplasia, spina bifida, polio and several infections and also injuries of the foot. This happens because a damage in the neural pathway causes muscular hypoplasia and muscular balance disorder to the affected area. Moreover, normal growth suspension at an early embryological stage is considered the main cause and can be attributed to external or internal causes. At first the above mentioned suspension causes the foot bone to be deformed even while the embryo is in the uterus, following a muscular balance disorder. [7]

In congenital muscular FV the foot bones alone are not yet deformed at birth. However their anatomic relations have already been disturbed. This disorder, though, burdens the

foot, negatively affects its bone growth and makes the deformation permanent. [6]

#### IV. SYMPTOMS

The foot is abnormal at 3 levels. The skin folds are marked on the inner concave surface of the foot, have disappeared from the outer curved surface, while the outer skin is thinner. As for the protruding bones, disorders are found in the ankle and the navicular bone. More specifically the outer ankle protrudes more and is further back than the inner ankle. [7] The navicular bone touches the inner ankle, while the front part of the ankle protrudes in the outer surface of the foot. Tendons (Achilles, posterior tibial) are found to be contracted during palpation. Calf atrophy, leg shortening, and even leg length discrepancies are found in various degrees. [8]

#### V. DIAGNOSIS

FV can be diagnosed from the 18<sup>th</sup> to 20<sup>th</sup> week of pregnancy with an echo, which should look for any other anatomic abnormalities and trisomy indicators. When there are no trisomy indicators and FV is the only finding, association with the expected danger is recommended, preferably with the biochemical check – up of the first of second term, which will determine how the finding will be handled. [9, 10]

47XYY karyotype, present in 1:1000 births, is a rare chromosome abnormality. Prenatal diagnosis of the syndrome is usually random, as this does not combine with special echo findings. In most cases that are diagnosed before birth, amniocentesis during pregnancy takes place for other reasons (echo indicators, biochemical tests causing suspicion, age, history, parents' wish). People with 47XYY karyotype are not diagnosed in their entire life, as they do not manifest special characteristics or serious abnormalities. [11, 12]

Quite often an intrauterine diagnosis of FV determines how serious the deformation will be, thus enabling the new parents to be informed about the disease, by orthopedic surgeon for children, before their child's birth and to choose the kind of treatment to be followed after birth. [13]

#### VI. TREATMENT METHODS

Fv prognosis is effective when right after birth an appropriate treatment method is used, because FV is flexible and malleable only in the first days after birth. The treatment aims to fully restore the deformation and help pronator and extensor muscles to function well. At first treatment is always conservative. [14]

##### A. Maintenance treatment

This includes a knee-ankle-foot plaster cast which is placed with a bent knee and the foot turned outwards and taking additional restrictive measures on the protection of the child. [15]

First every week and then every two weeks it is changed, while the equinus and FV are progressively and simultaneously corrected. This cast is placed

circumferentially with a direction from the outside edge of the foot to the dorsal surface and subsequently the inner edge of the foot and the plantar surface. What follows is a functional treatment with a Devis Browne or Alfa flex splint for 4 months. [2]

In this Devis Browne or Alfa flex treatment the FV foot is placed onto the cast sole and fastened with adhesive tape. These splint soles are joined together by a metal rod and fixed onto a rotating ring, so that the hip joint and knee can move. The position of the cast sole on the rod is not stable; in this way the position of the foot can be corrected. This technique, however, presents a major drawback: the hospitalization for several months. [16]

If within 3-4 months of maintenance treatment we achieve a satisfactory correction of the foot, we should maintain this with plaster casts or variable nocturnal braces and even physiotherapy of the pronators and extensor muscles. [17] When the child starts to stand up, then FV treads are administered based on a foot mould. FV treatment is considered successful only when the foot acquires a normal form, can stand normally and the power of the pronators balances the power of the supinator muscles. [18]

However, the method chosen today for tackling FV is the Ponseti Method, bearing its creator's (Ignacio Ponseti) name. It has been applied in the USA since the '50s, but in recent years has been accepted and widely practiced in Europe. It is a special handling of the foot on a weekly basis, in which plaster cast is placed with a specific technique. It usually requires 5-7 casts and in the majority of children percutaneous tenotomy of the Achilles tendon before applying the last plaster is required. [19] Then the child wears a special brace (shoes with bars) in order to maintain the correction of the foot. The brace is applied for 23 hours for the first 3 months and then at bedtime until the age of 3.5-4 years. The final result is a normal in appearance foot, flexible and functional for the whole life of the child. The child may be involved in any activity without lagging behind children his age. [20]

When maintenance treatment does not produce a quite good result, then we must intervene surgically, because heavy shrinkage cannot be dealt with in any other way. If now the deformation is caused by a deformation in the foot skeleton, then we must surgically intervene to the bones as well.

##### B. Surgical Treatment

Surgery time varies, with extreme limits being the neonatal period and the second or third year of life. The most commonly accepted view is for the surgery to take place after 2-3 months of continuous maintenance therapy and at the age of 1-2, that is before the child starts walking. The surgery that is performed to treat FV aims at the soft tissues and bones in the area. [21]

This surgery on the soft tissues has a dual purpose [22]:

1. to eliminate all those obstacles which hinder the correction of the deformation, with the various tendon, bursa and ligament sections, and the cross-section of the plantar fascia and
2. to achieve a muscular balance in the muscles of the foot through the various tendon transfers

Bone surgery also has a dual purpose [22]:

1. With different osteotomies permanent bone deformities are corrected. (The developing skeleton

must be given special care to avoid damage to the metaphysis and articular cartilage).

2. With different kinds of arthrodesis the foot skeleton is stabilised, enabled to charge and the child is relieved from the pain.

Thus, the simultaneous operation of both soft tissue and bone in the area can have positive results and fully correct FV to such an extent, that the leg after a certain time of recovery is normal. [23, 24] Studies have proven that after surgery and during the hospitalization, the play is important through the expression of the psychology of the child and the speedy recovery. [25]

## VII. CONCLUSION

FV is a condition in which early application of maintenance treatment is considered essential, while surgery in cases of incomplete correction of the deformations can be complementary. [26, 27] The goal of FV treatment is for the child to have a normal, functional and painless foot, but also to keep it during all stages of development and adult life. [28]

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