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PEDIATRIC FLAT FEET

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Abstract: A flat foot is a foot with a large plantar contact area. Flat feet are classified as physiologic or pathologic. We will described each type of deformity. Physiologic flat feet are flexible, common and benign. Children with physiologically flat feet often have a stretchy ligament; it is a normal variant which needs treatment. A pathological flat foot is cause by: caclaneovalgus deformity, tarsal coalition, congenital vertical talus, accessory navicular hypermobile flat foot with heel-cord contracture, z-foot or skew foot. A pathologic flat foot shows some degree of stiffness, often causes disability, and usually requires treatment.
We have operated on 45 patients with an average age 13.5 years inserting an implant into the sinus tarsi to establish a medial foot arch (arthroeresisi). In the clinical study in the third month after the operation, an improvement in the appearance and function of the foot was observed in 93% of patients.

Key words: child, foot, laxity, arthroereisis.

What are flat feet?

Most children feet have a space on the inner side, where the bottom of the foot is off the ground (the "arch" of the foot). The height of this arch is different. Small children do not have an arch; it develops between the ages of 3 and 10. As children grow and walk, the soft tissues along the bottom of the feet tighten, which gradually shapes the arches of the feet. However, the arch may never form in some children [1–5].

Children who have a low arch, or no arch at all are said to have flat feet. Sometimes they are said to have "fallen arches". The flat foot is often associated with a valgus heel (Fig. 1). Flat feet are classified as physiologic or pathologic [1].

Physiological or normal flat feet.

Physiologic flat feet are flexible, common and benign. The flatness is a variation of normal. The arch is flattened, but the foot is supple and pain free. When you stand on tiptoes the arch feet often have stretchy ligaments (Fig. 2). Children with physiologically flat feet often have stretchy ligaments (hypermobility). The hypermobile flat foot persists as a normal variant; there is no structural abnormality which needs treatment. Shoes tend to wear out more quickly in children with flat feet. Simply wearing comfortable shoes is the best treatment. Corrective shoes for a flexible flat foot was found not effective in the development of foot arches. Therefore, they should be limited only to selective cases [5–7].

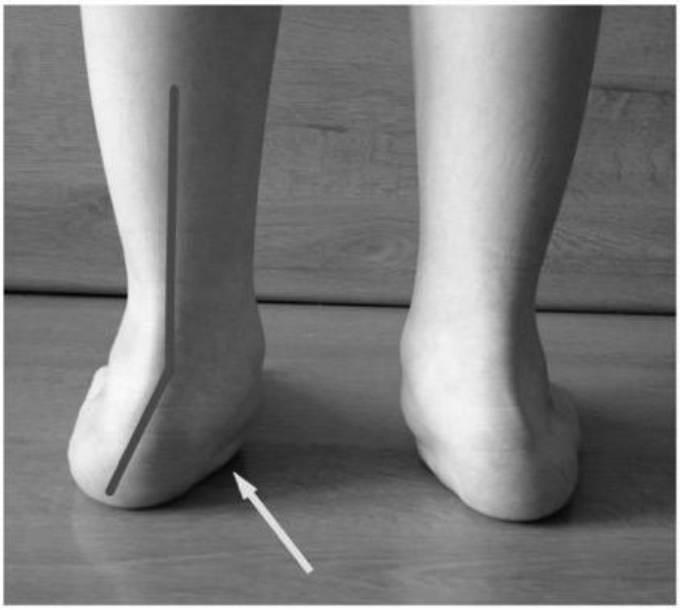

Fig. 1: Flat foot, bilateral (black line – valgus heel; white arrow – the arch is collapsed (loss)).

Pathological or painful flat feet

A small number of children have flat feet, which are a problem, and they require treatment. A pathological flat foot is caused by:

- Calcaneovalgus deformity;
- Tarsal coalition;
- Congenital vertical talus;
- Accessory navicular;

A

B

Fig. 2: Test for flexible flat foot. A – absence of longitudinale arch, B – longitudinale arch is present while the patient is standing on his/her toes.

- Hypermobile flat foot with heel-cord contracture;
- Z-fast or skew foot.

Calcaneovalgus deformity

This congenital deformity is due to intrauterine crowding which produces calcaneus and valgus. The calcaneovalgus foot is very flexible, and the calcaneus lies in dorsiflexion. This condition may be associated with the developmental of hip dysplasia. Because the calcaneovalgus is a positional deformity, it resolves spontaneously without treatment [1, 8].

Tarsal coalition

Tarsal coalition is a bony of fibrocartilaginous connection of two or more tarsal bones. The cause is unknown, but it has been established that the condition results from the failure of differentiation and segmentation of primitive mesenchyme [1]. In infancy and early childhood, the condition is usually asymptomatic and is rarely seen. Symptoms and signs usually tend to appear during the second decade of life, when the stress and strain on the tarsus are increased by greater body weight and strenuous physical activities, such as sports. The history is often one of vague pain in the mid-tarsal region, usually associated with activity. There may be an increased incidence of ankle sprains [9–11].

Congenital vertical talus

The vertical talus is the most severe and serious pathologic flat foot. It is a congenital deformity that produces not only flattening but an actual convexity of the sole of the foot. Vertical talus is usually associated with other conditions such as myelodysplasia and arthrogryposis. The diagnosis is suggested by a lateral radiograph of the foot showing the vertical orientation of the talus (Fig. 3) [1].

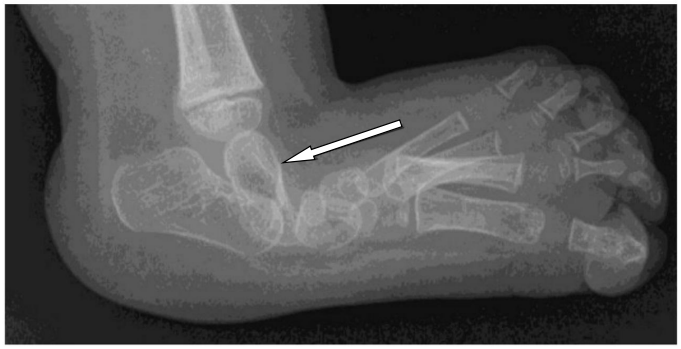

Fig. 3: Vertical orientation of talus (white arrow).

Accessory navicular

This extra bone is present in about 10% of people. The accessory navicular is located on the medial aspect of the foot and often produces a prominence (Fig. 4). When this bone is symptomatic, due to bunion formation, tenderness and pain, surgery may be necessary [12, 13].

Hypermobile flat foot with heel – cord contracture (tight Achilles tendon)

Heel – cord contracture causes heel valgus, altered tarsal motion, lateral column shortening, and pain. The foot is flat on standing and heel – cord is contracted. The child

Fig. 4: Accessory navicular, bilateral (white arrows).

is usually in the second decade of life and has vague activity – related foot pain. The foot cannot be dorsiflexed beyond neutral with the knee extended and the subtalar joint inverted to neutral. This condition is often confused with simple hypermobile flatfoot. Treatment involves the lengthening of the contracture of the triceps surae and in many cases lateral column lengthening [14, 15].

Skew – foot

Z – foot or skew – foot is a birth defect in which the foot is highly deformed. The front foot is deviated inwards and the back foot is deviated outwards, giving the foot a shape like the letter "Z". The Achilles tendon is also shortened. The aetiology of this rare condition is unknown. It is seen in children with myelodysplasia or cerebral palsy. Surgical stabilization of the back foot with Achilles tendon lengthening and realignment of the bones of the forefoot are necessary [16].

Diagnosis

The evaluation of flat foot should include the examination all musculoskeletal system. At first we ought to determine joint laxity. Four specific tests are widely used to evaluate generalized ligamentous laxity: (1) ability to passively hyperextend the index finger metacarpophalangeal joint more than 900, (2) ability to passively touch the thumb to the adjacent forearm, (3) ability to hyperextend the elbows, and (4) ability to hyperextend the knees. A child who can perform three or four of these tests is considered ligamentously lax [17] (Fig. 5).

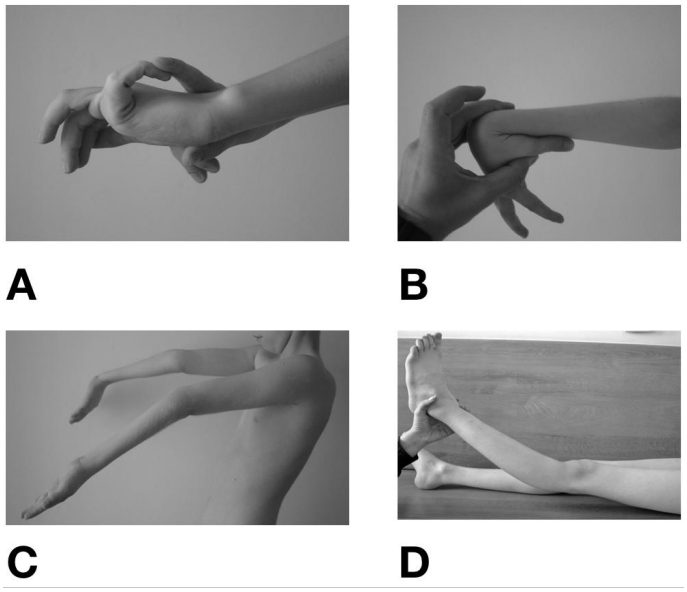

Fig. 5: Joint laxity test, (A) ability to passively hyperextend the index finger metacarpophalangeal joint more than 90°, (B) ability to passively touch the thumb to the adjacent forearm, (C) ability to hyperextend the elbow, (D) ability to hyperextend the knees.

In children with flat feet, the instep of the foot comes in contact with the ground when standing. To diagnose this problem, the physician will ask you to stand on your toes, if an arch forms, the flat foot is called flexible (Fig. 6). You will not need any more tests or treatment. If the arch does not form with toe-standing, or there is pain; other tests are needed [1, 2].

The second important component of examination is as assessment length of calcaneal tendon. It can be recorded indirectly as the maximal angle of passive dorsiflexion of the foot with the subtalar joint in a neutral position and the knee extended. Less than 10° of dorsiflexion suggests Achilles tendon contracture [2].

Great toe extension test. Passive extension of the great toe at the metatarsophalangeal joint in the normal weight-bearing foot should be done (Fig. 7). A lack of reconstructed medial longitudinal arch during toe extension proves a structural deformation of the foot [2].

Standing foot x-rays are useful to show the degree of deformity:

- standing lateral view shows the longitudinal arch and talo-navicular joint;
- standing ap view shows the degree of heel valgus (talo-calcaneal angle).

Computer tomography (CT) is the method of choice for the diagnosis of tarsal coalitions. Magnetic resonance

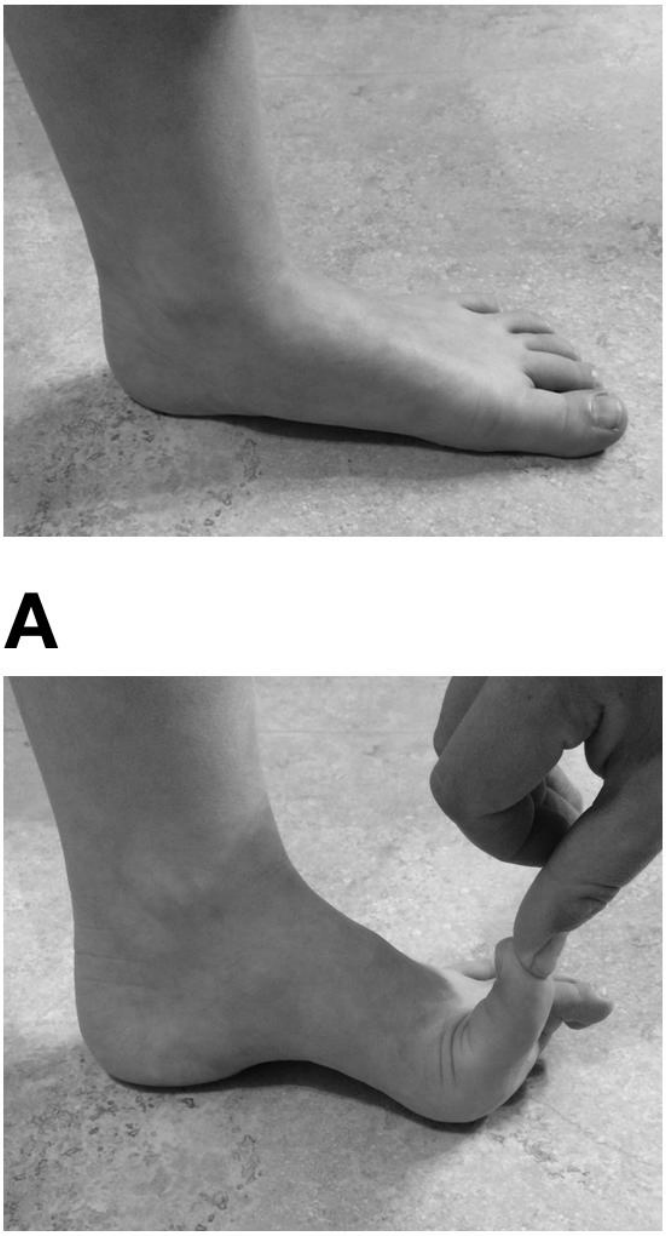

Fig. 6: Great toe extension test: A – absence of longitudinale arch, B – longitudinale arch present during the extension of a toe.

imaging (MRI) provides the advantage of demonstrating fibrous coalitions [18].

Treatment

Flat feet in a child do not need treatment if they are not causing pain or walking problems. Children feet will grow and develop the same, whether special shoes, shoe inserts, heel cups, or wedges are used. Your child may walk barefoot, run, jump, or do any other activity without making the flat

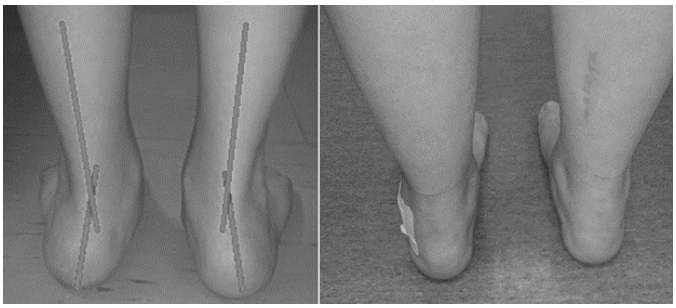

Fig. 7: Clinical study one month after the operation.

feet worse. In older children and adults, flexible flat feet that do not cause pain or walking problems do not need further treatment [1, 5, 19–21].

If a child has pain due to flexible flat feet, the following may help:

- activity modifications, cut down on activities that bring pain and avoid prolonged walking an standing to give arches a rest.
- weight loss, putting too much weight on arches may aggravate symptoms.
- shoe inserts called orthotics. These custom-modelled arches made of composite materials provide support and relieve pain. Shoe inserts not only help children with a flat foot to walk comfortably, they also extend the life of their shoes, which otherwise would wear unevenly. However, shoe inserts won't help a child develop an arch and sometimes may cause more problems than the flat feet themselves. Shoe inserts may cause sores or pressure areas on the inner side of the foot.
- physical therapy may be used to provide temporary relief.
- some children have tightness of the heel cord (Achilles tendon) that limits the motion of the foot. Stretching exercises for the heel cord ought to be recommended.

Surgery treatment

Surgical intervention for flexible flat feet is reserved for patients who have persistent localized symptoms despite conservative care. Surgical procedures include Achilles tendon lengthening, bone-cutting procedures that rearrange the alignment of the foot (osteotomies), fusion of joints (arthrodesis), or the insertion of a silicone or metal cap into sinus tarsi to establish a medial foot arch (arthroereisis).

Our experience in treatment with arthroereisis

The optimal treatment methods of flat foot have been sought for many years. Currently, the method of choice for

dynamic disorders is support and stabilization of the displaced talus with the use of implant inserted into the sinus tarsi and extension of the gastrocnemius muscle fascia.

Arthroeresis has gained popularity in Europe but has not been widely adopted in North America [22]. This method is used in paediatric and adult patients with flexible/reducible talotarsal joint dislocation [23, 24]. Presumably, the screw achieves correction by stimulating the proprioceptive receptors allowing active inversion of the foot.

We have operated on 45 patients (the average age was 13.5 years) with this method. Additionally, in 26 cases fascia of the gastrocnemius muscle had to be extended with the use of the Vulpius method. In the clinical study in the third month after the operation, an improvement in the appearance and function of the foot was observed in 93% of patients (Fig. 7). The average duration of postoperative pain was 4 weeks and 3 days. To evaluate the result pre- and postoperative pictures were compared. We used to describe the X-ray angles Nikolayev, Bohler, Hollow and Strock. On the pre- and postoperative X-ray images (Fig. 8), angles rates of the feet improved by an average of 10 points, at 75.6% of patients; this result was within limits of the physiological norm (Fig. 9). The correction of a flexible flat foot in children with the use of implant improves the appearance of the feet and the children's self-esteem as well as reduces pain.

Fig. 8: The x-ray of foot pre- (A) and postoperative (B) of a thirteen-year-old boy.

The arthroereisis sinus tarsi by implant restores and maintains the physiologic alignment between the talus and calcaneus while allowing the bones of the foot to remodel to normal functional anatomy during the subsequent period of growth. This procedure is less morbidity to the patient and technically easier to perform.

Angle	Norm	Preoperative n=45	Postoperative n=45	Correction
Nikołajew	20-30°	11,4°	17,7°	6,4°
Hollow	150°	168,9°	159,6°	9,3°
Böhler	20-40°	53,9°	37,4°	16,5°
Strock	50°	54,5°	50,1°	7,8°

Fig. 9: The angels ranges of the feet pre- and postoperative.

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