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SIMPLE METHODS FOR DETERMINING FOOT DEFORMITY

JEDNOSTAVNE METODE ZA PROCJENU DEFORMITETA STOPALA

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ABSTRACT

The cause of foot deformities is contained in insufficient physical activity of children, inadequate diet that increases obesity, as well as uncomfortable and inadequate footwear. Timely diagnosis increases the prevention and remediation of this deformity, which, if not treated properly, causes disruption of other parts of the posture of the body. There are various methods for diagnosing this disorder, from the most complex ones to the simplest ones - which are presented in this paper. Mayer's, Thomsen's, Chizhin's, Russian and German methods are realized with sufficient knowledge, and with minor material and technical requirements. This paper is aimed at presenting and explaining the application of these methods, each of which provides satisfactory indicators of foot deformity and can fully guide the work of the teaching staff. Foot deformity requires a long-term approach to treatment so it needs to be detected as early as possible. As recommended in this paper, this can be done in the fifth grade of elementary school at the latest.

Key words: Elementary School, Mayer, Thomsen, Chizhin, Russian method, German method

SAŽETAK

Uzrok nastanku deformiteta stopala sadržan je u nedovoljnoj tjelesnoj aktivnosti djece, neadekvatnoj ishrani koja povećava pretilost kao i neugodnoj i uopšte neadekvatnoj obući. Pravovremena dijagnostika povećava spriječavanje i saniranje ovog deformiteta, koji ukoliko se ne liječi na odgovarajući način, uzrokuje narušavanje i drugih dijelova posture tijela. Postoje različite metode za dijagnozu ovog poremećaja, od onih najsloženijih do jednostavnijih - koje su predstavljene u ovom radu. Mayerova, Tomsenova, Čižinova, Ruska i Njemačka metoda realizuju se uz dovoljno znanja, a uz male materijalno - tehničke zahtjeve. Ovaj rad usmjeren je na predstavljanje i objašnjenje primjene navedenih metoda, od kojih

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svaka daje zadovoljavajuće pokazatelje o deformitetu stopala i u potpunosti može usmjeriti rad nastavnog kadra. Deformitet stopala zatijeva dugotrajan pristup u liječenju tako da ga je potrebno što ranije otkriti. Kako je u ovom radu preporučeno to može biti najkasnije u petom razredu osnovne škole.

Ključne riječi: Osnovna škola, Mayer, Tomsen, Čižin, Ruski metod, Njemački metod.

INTRODUCTION

The static role of the foot is reflected in taking over and carrying the entire weight of the body and distributing it to the basic fulcrums. Due to the load, the foot is subject to various changes in relation to the normal status. The static role of the foot is actively played by the muscles of the lower leg and foot, and passively by numerous interosseous ligaments as well as bones. Contact with the ground is made by the foot over three basic points of support (fulcrums): the nodules of the heel bone and the head of the first and fifth metatarsal bones (Ćibo, 2001; Guyton, & Hall, 2012). The flat foot represents the most common (Beganović, & Bešović, 2012a: Beganović, & Bešović, 2012b) deformity of the lower extremities, with the loss (lowering) of the physiological arches. It can be congenital and acquired (within the framework of this paper, the acquired lowered foot arch will be analyzed). Congenital flat foot should not be equated with the so-called "seemingly congenital flat foot" with which the child is born and which arises as a consequence of increased adipose tissue in the area of the plantum of the foot (Beganović & Bešović, 2011; Bjeković et al., 2011). It is a "fat cushion" that is gradually lost under the influence of functional stimuli, in the period when the child begins to get up and walk. After the second year of life, the arches of the feet gradually acquire their physiological appearance. Research (Krsmanović, 2007) has shown that about 20% of newborns have a certain level of deformity that is mild and without pathological significance. Deformity of the acquired flat foot occurs during development, especially if there are certain congenital predispositions. Acquired flat foot[1] can occur as a result of:

- hypokinesia,
- increased body weight,
- rickets at birth, and in the period of growth and development,
- traumatic factors,
- professional deformities,
- improperly selected and worn footwear.

There are three critical periods in the development of this deformity (Mađarević & Mustafičić, 2011):

- Infantile period - the phase of the child's uprightness, when it changes from a "four-legged" position to a standing one. This process should take place gradually and the child should only gradually move to an upright position. Premature and violent righting (often by parents or with the use of walking aids such as baby-walkers and baby-chairs) is not good for proper foot development.

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- Adolescent period - a phase of accelerated growth and muscle weakness, with violent hormonal changes can contribute to the creation of a weak and loose loco-motor system, including the feet.
- The third delicate period - the adult age, where people whose occupations require a standing position (caterers, traders, dentists, surgeons) or people whose occupations require carrying of heavy loads, can develop a disorder in posture.

How a flat foot is formed

Disorders of statics and normal appearance of the foot occur in the case of a disproportion between the active strength of the foot and the load force (Copeland & Solomon, 1991). At the same time, the strength of the muscles first decreases, then the ligaments stretch and finally the shape of the skeleton of the foot changes. Such disorders are manifested by the lowering of the arches of the feet and the appearance of a flat foot. First, the head of the talus (which forms the middle part of the tarsus) moves down (plantarly) and inwards (medially), and the position of the calcaneus changes at the same time. The calcaneus occupies the valgus position and this represents the first phase of the lowering of the longitudinal arch[1]. If this phase is not stopped, the navicular bone[2] and the cuboid bone[3] are further lowered, and the longitudinal and transverse arches are lowered, and another phase called PES PLANO-VALGUS occurs. Simultaneously with the changes in the longitudinal and transverse arch, the heads of the metatarsal bones move away and descend, which represents the third phase of the lowering of the foot arch (PES TRANSVERSO - PLANUS). The shape and type of the foot is determined by the length of the toes, and based on that there are three basic types of feet: square, Egyptian and Greek.

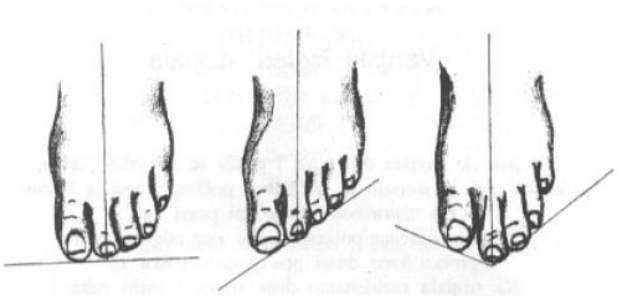

Figure 1. From left to right: Square, Egyptian and Greek foot [4]

Symptoms that indicate altered foot status are:

- pain occurring in the navicular bone, the middle part of the dorsum of the foot and the front part of the calcaneus,
- altered shape on the Achilles tendon, its distortion with inward convexity,
- valgus position of the heel,

[2] Os naviculare
[3] Os cuboideum
[4] http://paedcro.com/hr/1287-pretraga-po-naslovu/271-271, Accessed on October 20th 2020

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- change in the position of the big toe that rotates around the longitudinal axis, the toenail rotates medially, and the whole big toe is abducted,
- the inner malleolus is bulged towards the medial side, it is enlarged and lowered,
- the front part of the foot is abducted and pronated,
- patient's shoe (the heel of the shoe is more worn out on the inside), and
- pain in the lumbosacral region.

Methods for determining deformity

Diagnosis of a flat foot is performed in two ways:

- by clinical examination and
- by technical aids.

Clinical examination is usually performed by a physician/doctor (Krajcinović, 1995). He/she approaches the analysis of the appearance of the feet by individual details and as a whole. In terms of detail, the feet should be observed from the front, back, side and plantar side. The results of the observation should be compared with the correct appearance of feet. In order to determine the degree of the lowering of the foot arch, the respondent is required to raise his/her heels and keep the position of standing on his/her toes. In this position, attention is focused on the position of the Achilles tendons. Their correction, i.e. return to the vertical position in relation to the calcaneus, indicates that the changes are still functional. Additional exercise and movement activities can help in aiding this form of deformity. Next, the foot is examined from the side. The relationship between the foot and lower leg, then the position and appearance of the longitudinal arch, and especially the navicular bone, is determined. From this position, the degree of the lowering of the arch is determined. Respondents are required to raise one and maintain a stance on the other leg/foot. Under the influence of the respondent's weight, the muscles of the lower leg and the foot of the standing leg contract and raise the longitudinal arch of the foot. Its fixing and maintenance, indicates the so-called muscular phase of the lowered foot (functional changes). Additional exercises and increased motor activity also help with the appearance of this level of deformity (Hadžikadunić & Balta, 2004). If this test shows a short-term fix and re-lowering of the arch, it is a sign that the changes have progressed. Retaining the adhered sole to the ground during this test indicates the third - most severe phase of deformity. Within the most difficult phase, additional exercise and activity are only part of the overall therapeutic procedure. The position of the front part of the foot, the position of the toes and the big toe are observed from the front.

The use of various aids in the process of determining a flat foot can contribute to a more precise determination of the degree of deformity. In health institutions, special devices are used, such as a podoscope for direct visual observation of the plantar surface, a fluorescent pedograph and a photocell recorder. In addition to the above, a classic plantograph can be painted with colour applied to the foot and an imprint on paper. The advantage of using a classic plantograph is simple realization, with low material costs and simple determination of the degree of deformity.

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Simple methods for determining foot deformity

Simple methods for taking plantograms are based on taking a footprint on an A4-format-paper (Trošt et al., 2005). The foot is pre-coated with easily washable indigo paint, ink, pigmented paint and the like. The paint is applied with a roller on which the paint is evenly applied. Another way to apply the paint on the foot is when a metal or plastic container is used, at the bottom of which multi-layer gauze is placed. The gauze is evenly soaked in the coloured substance. Both feet are placed into the bowl at the same time. After one or the other foot is coated with paint, the respondent will stand on an A4-format- paper, leaving a sole print in the middle of the paper. After that, the analysis of plantograms is approached. There are several methods by which the obtained imprint is analyzed (Turk, E. 2011) and the most common are: Mayer's method, Thomsen's method, Chizhin's method, German method and Russian method.

Mayer's method of determining foot deformity

On the footprint, a line is drawn that runs from the most protruding part of the heel bone to the medial edge of the fourth toe. We call this line the Mayer line. If the central part of the footprint exceeds the Mayer line, it is considered that the respondent has a foot deformity (Ahmetović, 2015; Rašidagić & Nikšić, 2014). The more the print crosses the Mayer line, the greater the deformation. The method is reliable, but its main drawback is slightly lower precision in determining the degree of deformity.

Figure 2. Mayer's method of determining foot deformity

Thomsen's method of determining foot deformity

Thomsen's method is implemented in the following way (Nikšić and other authors, 2015b; Rašidagić & Mekić, 2018): from the centre of the heel, which is precisely determined on the plantogram, a line is drawn towards the lateral edge of the third toe. It represents the boundary line between a normal and a lowered foot arch and is known as the Mayer line. If the footprint does not cross this line towards the medial edge of the foot, it is a proper foot according to the criteria of this method. The crossing of the footprint over this line indicates a certain lowering of the longitudinal arch of the foot and dictates the need for further analysis of the plantogram. Further processing involves drawing a tangent that connects the most protruding part of the imprint of the medial edge of the heel with the imprint of the front part of the foot. After that, the nearest part of the footprint around the middle of its plantum (line segment A), expressed in millimetres, is linked with the Mayer line with a ruler at a right angle. Then from the same point, from the Mayer line, vertical to the tangent that connects the heel and the front part of the foot, (line segment B), expressed in millimetres, is drawn. After obtaining these two values, in order to calculate the index of the percentage of the longitudinal arch of the foot, they are placed in relation to each other (A / B * 100). The obtained percentage indicates the size of the lowering of the longitudinal arch of the foot, as follows:

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- 1-30% represents the first degree of the lowering of the foot arch,
- 31 - 60% represents the II degree of the lowering of the foot arch,
- over 61% represents the III degree of the lowering of the foot arch.

The disadvantage of this method is that people with a normal arch of the foot are left without an index, i.e. the index is zero, which makes static data processing more difficult.

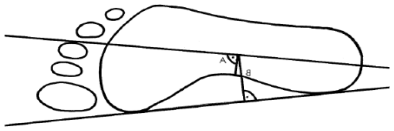

Figure 3. Thomsen's method of determining foot deformity [5]

Chizhin's method of determining foot deformity

Chizhin's method for estimating plantograms involves dividing the foot with three lines. From the inside of the plantogram, the first line "AB" is drawn, which connects the most protruding medial part of the heel print to the anterior medial part of the foot at the height of the first metatarsal bone. The second line "CD" is drawn through the middle of the plantogram. This line connects the middle of the second toe and the middle of the last most protruding part of the heel. The third line "EF" runs perpendicular to the line "CD" through the middle of the foot and divides the foot into two equal halves. On the line "EF", point "a" is determined (contact of the line "EF" with the outer part of the foot), then point "b" (contact of the inner part of the foot with the ground) and finally point "c" (contact of the line "EF" with the line "AB "). The index of the lowering of the foot arch is calculated via the formula I = ab / bc. Estimation of deformity is determined by the formula:

- I = 0 to 1, normal foot (arch)
- I = 1.01 to 2, marginally lowered foot (arch)
- I = 2.01 and higher, represents a very lowered foot (arch)
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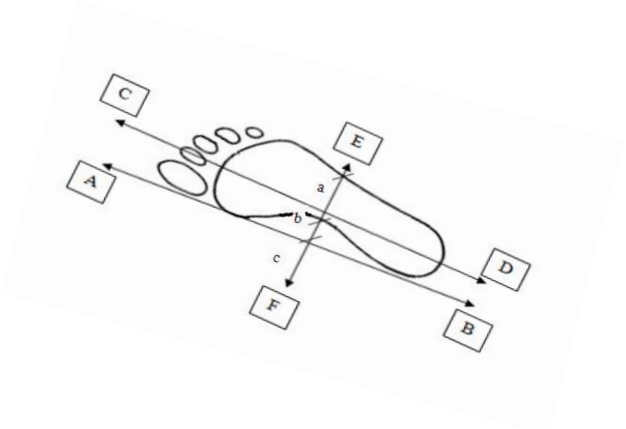

Figure 4. Chizhin's method for determining foot deformity

[5] Cited/taken from „Korektivna gimnastika“, Ilić.2012

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German method of determining foot deformity

This method divides the foot into three thirds. A transverse line is drawn on the widest part of the heel over the footprint. On the transversely drawn line over the heel, four points are marked that are evenly spaced, starting from the contact of the transverse line with the foot (medially and laterally). After this, line segments are drawn along the footprint, so that the first line segment (line) passes from the outside of the foot (laterally), the second line segment passes between the third and fourth toe and the first point marked on the transverse line of the heel, the third line segment passes between the big toe and middle toe and the second point marked on the transverse line, and the fourth line segment passes from the inside of the foot, touching the foot at the most protruding part of the footprint. If the inner arch of the foot is located within 2/3 of the drawn lines, then the foot is considered to be "not deformed".

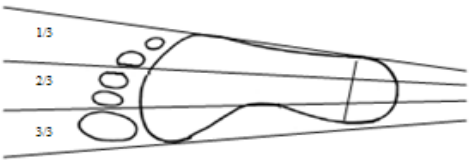

Figure 5. German method of determining foot deformity

Russian method of determining foot deformity

The method of Russian authors is also a very simple method for determining foot deformities. The plantogram is divided into five equal parts in the front part of the foot at the height of the first and fifth metatarsal bones, as well as the imprint of the heel. If the footprint, observed from the outside to the inside, does not exceed two of the five drawn fields, it is considered that there is no foot deformity. If the footprint covers three of the five drawn fields, it represents the first degree of foot deformity, if the footprint covers four of the five drawn fields, it represents the second degree of foot deformity, and if the footprint covers the fifth drawn field or more, the foot is considered to be in the third degree of deformity.

- 3/5 of the plantogram = I degree of lowered foot (arch),
- 4 / 5 of the plantogram = II degree of lowered foot (arch); and
- 5/5 of the plantogram = III degree of lowered foot (arch).

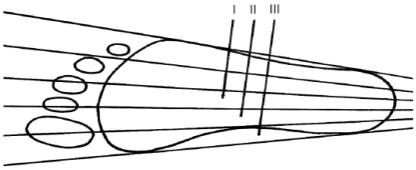

Figure 6. Method of Russian authors [6]

[6] Cited/taken from „Korektivna gimnastika“, Ilić.2012.

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CONCLUSION

Violation of the proper status of feet should be a warning to physical education teachers that children will not be able to fully realize all the teaching contents. It has been determined that a deformed foot causes various interfering factors that can manifest through a sore foot, pain in the tendons, lower legs and knees. Students may also experience various hesitations due to the appearance of poor leg posture (X legs), a disorder that also occurs as a result of foot deformities. Due to all the above, preventive action is needed (Rašidagić and other authors in 2016) by applying various shaping exercises that raise the functionality of the feet. The teaching staff in the classes, and also the coaches familiar with these indicators - in training, can measure the status of the feet. After that, depending on the determined degree of deformity, the rehabilitation of that disorder is approached. If the deformities are of a functional nature, exercises are planned with the students to restore their functional status (Rašidagić, 2011). If a structural disorder in the posture of the feet is determined, special exercises can stop the disorder (Krsmanović, 2007), but also, the child could be sent to a doctor. In their work, the teaching staff should also apply the teaching principle called the "principle of unified action", on the basis of which parents, doctors, coaches and others should be acquainted with the measurement results. Then other necessary measures can be taken to fix the deformity (making an orthopaedic insole, for example). Foot deformity requires a long-term approach in remediation, and prognosis is better if a timely diagnosis is established. Since the teaching of physical education and health education is taken over by sports teachers and physical education teachers already in the fifth grade of elementary school, this period could be stated as the final period for determining the status of feet (Hadžikadunić, 2000). In this paper, simple methods for determining foot deformities are presented, and well explained, each of which provides quite sufficient opportunities to be applied in the teaching process, also to teachers who were not enough familiar with them (Imamović-Turković and other authors, 2019). The teaching staff should work on informing both students and parents about the way of choosing sneakers and other footwear, but also the way of appropriate nutrition that will be aimed at reducing the obesity of students.

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