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Analysis of selected methods of diagnostics and physiotherapy of pes plano-valgus in children

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Summary

Introduction: Flat feet is one of the most common posture defects among children and it usually co-occurs with valgus of the heels, which is called pes plano-valgus. There are many diagnostic methods and physiotherapeutic activities that allow for early detection and appropriate correction of the defect. The use of non-surgical methods may allow the child to avoid surgery in the future.

Aim and Methods: Review and analysis of the current scientific literature on the diagnosis and physiotherapy of plano-valgus feet in children.

Conclusions: In the diagnostic process, there are many static and dynamic methods for the assessment of plano-valgus foot among children. Special devices such as plantoconturograph, podoscope, and pedobarographic mat are used in the diagnosis of feet in children and have proven to be helpful in the detailed analysis of foot defects. However, an extensive range of physiotherapeutic methods allows for comprehensive treatment using not only corrective exercises, but also physical therapy treatments in order to relieve pain and accelerate recovery. Orthopedic appliances, such as supination insoles, also play an important role in the treatment. The best results were seen in the use of comprehensive treatment and multiple therapeutic methods.

Early detection and correct diagnosis of foot abnormalities allow for appropriate treatment with the use of a wide range of physiotherapy methods. This increases the chances of restoring normal foot functions among children and reducing pain with other abnormal symptoms.

Key words: flat feet, pes plano-valgus, children

1. Introduction

Nowadays, body posture is a serious health problem among children. One of the most common body posture defects are foot defects. We can observe lowering the arches of the foot among children very often. If neglected, it can lead to additional valgus of the heel. Then, we are talking about plano valgus feet, which reduce the comfort of a child's life and entail abnormal development in the musculoskeletal system. To prevent this, there are many methods of treatment and prevention of flat valgus feet. Physiotherapy plays a very important role in treating the plano-valgus feet. A wide range of applications and methods can be effectively and individually adapted to the appropriate rehabilitation program for a patient.

2. Aim

The main aim of the study is to analyze the scientific literature on the role of diagnostics and physiotherapy in the treatment of plano-valgus feet in children.

3.Methods

The presented research was carried out as part of the PhD thesis entitled: "Quality of life of children with plano-valgus feet after subtalar arthroereisis treatment", with the Agreement for the implementation of scientific and research work by a young scientist no. PCN-2-094/N/0/Z.

3.1.Development of the foot

A child is born with forefoot pronation and calcaneus supination^{1,2}. A newborn's feet filled with fat tissue form a fat pad, muscles and ligaments are weak, therefore the arches of the foot are small. We are talking then about congenital flat feet³. It is physiological and occurs in newborns and children. It should disappear as the child develops further. Arching of the foot appears gradually from around the age of 3. However, it may not be visible during this period due to a lot of fat tissue. This tissue gradually diminishes until around the age of 6. It provides foot protection and shock-absorption function. At the age of 6, the arches of the foot should be clearly marked: longitudinal and transverse^{1,7}. However, if the arches of the foot do not develop, and flat feet persists after 5-6 years of age and is connected with pain, then we speak of acquired flat feet⁶. This kind of flatfoot requires orthopedic consultation and the introduction of treatment and correction of the defect⁸.

The correct positioning of the foot is achieved by the upright positioning of the body during the child's development⁹. In this process, the foot is prepared to perform its functions. "The culmination of the developmental process is obtaining a vertical posture, that is, the ability to maintain the body weight on the plane of two feet"¹⁰. It should be remembered that standing up too early may lead to the development of posture defects, this is because the musculoskeletal system is not sufficiently developed. Parents or legal guardians should not disturb or accelerate the proper development of the child¹.

3.2.Etiology.

In a healthy foot, the heel axis is the extension of the calf axis. The correct heel axis deviation should be approximately 5 degrees. In the plano-valgus foot, we notice the lowering of the arches of the foot and also the deviation of the heel axis to the outside. Foot pronation is noticeable when the foot rests on the ground with the medial edge^{3,8}.

A flat valgus foot is the result of a child's abnormal development. This defect is related to the weakening of the ligaments and incorrect muscle tension. This leads to an incorrect load on the foot¹. As a result, flat feet and the calcaneus supination are fixed.

M. Matyja and A. Gogola write that the key factor in the proper development of a child is adequate muscle tone. If it is lowered or elevated, it can cause the development of a compensatory anti-gravity mechanism and body posture defects. During development period, the child performs a lot of lower limb movements, which lead to the proper development of the feet. All movements and activities performed by an infant are the basis for subsequent activities performed in later development. Incorrect base leads to the development of further abnormal movement patterns^{10,11}.

3.3.Diagnostics

We can notice plano-valgus foot in children around the age of 7. If the arches of the foot are not developed in the early school period and additionally calcaneus supination is visible, then we may suspect the presence of a plano valgus foot. Additional symptoms that we can notice in children are problems with movement, difficulties with maintaining balance and abnormal gait. Children may also complain of pain in the area of the feet during longer walks, jogging, etc. What's more, this pain may also appear in the area of the knee and hip joints or even in the area of the spine¹². As part of the physiotherapeutic process, we can also assess motor skills, walking, pain, fatigue, endurance and foot functions¹³.

In their work, K. Słonka and L Hyla-Klekot stress the importance of a physical examination that a doctor or a physiotherapist should perform in static and dynamic conditions. Body posture (including feet) should be assessed in three planes: sagittal, transverse and frontal. Feet should be hip-width apart with shoes and socks removed. During the observation, we evaluate the position of the foot in relation to the lower leg. If the heel is raised or turned outwards, then we can talk about calcaneus supination. The authors also show that it is important to observe the position of the toes. Often incorrect positioning of the toes (especially hallux) is connected with flat feet. Static tests can also be performed with the use of a podoscope, which will make it easier to read the test results. During the examination, we can see the picture of the foot showing the surface of the foot adjacent to the ground while standing. In dynamic research, the authors present a test of lifting both heels. Asymmetric lifting heels during standing on tiptoes, suggests shortening of the tibial muscle tendon, which may cause the development of foot defects. Pedobarographic examinations can be used to assess the feet, in both, static and dynamic conditions. It is a modern method of computer-based analysis of gait and foot structure¹.

J. Pauk and M. Derlatka in their study used anthropometric measurements to assess feet in children. The measurements included: length, circumference, width and height of the forefoot. Additionally, they used foot prints from a plantoconturograph to evaluate the feet of children. This test consists in imprinting the foot on a piece of paper with the use of ink and a special roller. This can be performed statically and dynamically. In the study, the authors showed that from some of the obtained data it is possible to recognize the plano-valgus foot. For instance, lower values of the height of the lateral and medial ankles and heels are noticeable in relation to children with normal feet. To evaluate the feet in children, the authors also used X-ray images taken while standing in the anterior-posterior and lateral projections. Based on the photos, it was possible to assess the angles of the foot cavity (between the calcaneal tumor, the cuboid bone and the heads of the metatarsal bones) and the Nikolajew angle (the line connecting the calcaneus tumor with the head of

the 5th metatarsal bone and the calcaneus tumor with the anterior-lower part of the calcaneus bone)¹⁴.

N. Skowron, R. Malak, E. Mojs and W. Samborski calculated the Clarke angle from the footprint on a paper to assess the arch of the foot. It is one of the most reliable foot measurements. The Clarke angle is between medial edge of the foot and the line connecting the point of the deepest indentation of the foot and the point of contact between the medial tangent with the edge of the foot. Based on this test, 70% of children were diagnosed with an abnormal arch of the foot^{15,7}.

In their research, K. Landorf, J. A. Radford and S. Hudson used the Visual Analogue Scale to evaluate the feet. It is a simple method that is used to evaluate subjectively variable symptoms, e.g. pain. In addition, the authors used the Foot Health Status Questionnaire (FHSQ). It is a questionnaire with questions about foot complaints, physical activity, shoes, general health, etc¹⁶.

3.4. Physiotherapy

Rehabilitation should be adapted individually to the patient. Factors that we take into account when selecting treatment methods are the etiology of the defect, gender and age¹⁷. Rehabilitation plays an important role in the treatment of plano-valgus feet. In this defect, the musculo-ligamentous system is weakened. In the literature, it is referred to as flexible flatfoot. Properly selected exercises can prevent the further development of the defect. These exercises can strengthen the stretched muscles, and stretch shortened muscle groups¹⁸.

In their research, C. Turner, M. D Gardiner, A. Midgley and A. Stefanis proved that non-surgical treatment, including physiotherapy, has a positive effect on the treatment process. They described how we can use physiotherapy to improve muscle strength in the feet. Each physiotherapist can use appropriately selected exercises to strengthen the arches of the foot. The authors show for example exercises such as: tiptoe walking, walking on the heels or barefoot on soft sand, bending the toes, rolling a ball under the arch of the foot, pretending to play the piano with the toes, and strong dorsiflexion of the toes. The authors encourage parents to play and exercise with their children during the day to make the exercises more effective¹³.

The effectiveness of physiotherapy is confirmed by I. Riccio et al. Three hundred children with flat feet participated in the study. Physiotherapy included simple exercises that were easy to learn. The results were compared to a group of children with flat feet that were treated by using orthoses, but without any exercise. The authors prove that the use of physical therapy exercises is more effective than the only use of orthoses⁹.

In their research, K. Niedzielski and K. Zwierzchowski also confirm the effectiveness of exercises and the rehabilitation process. Their study included 469 school-age children. The authors confirmed that the best results were among children who performed rehabilitation exercises and additionally used supination insoles. Complete improvement and elimination of defects were observed in 50% of children²⁰.

The authors M. Ismaeel and A. El-Tohamy also presented the effects of physiotherapy on the arch of the foot. The study group consisted of children aged 7-8 years. In their work, the authors incorporated soft exercises in a sitting position, weight-bearing exercises in a standing position and used orthopedic insoles. The exercises were performed for a period of 3 months, 6 times a week, for an hour. The authors proved that exercising has a positive effect on the arch of the foot. The best results are achieved when exercises are connected with supination insoles²¹.

We often hear that walking barefoot is healthy for children. Children are encouraged to walk barefoot on various surfaces, e.g. sand or grass. This helps in the proper development of the feet and the proper functioning of the muscles. This method is also recommended for children with flat feet or plano-valgus feet, if it does not cause pain. The effectiveness of barefoot walking was proved by H. V. Sharath and P. Chippala. They conducted the study on 38 children with flat feet. For 8 weeks, the children performed specific exercises with walking barefoot. The results showed a significant improvement, demonstrating the effectiveness of barefoot walking²².

Short-foot exercises (SFE) can also be used in the physiotherapy of the plano-valgus feet.

K. Walkowska and S. Siwiec write about the use of SFE in the correction of flat feet. The aim of the SFE exercises is to increase the longitudinal arch of the foot by exercising with intrinsic muscles. These exercises are important in proprioceptive training. The exercises involve weight-bearing the foot at three points of the foot (1st metatarsal bone, 5th metatarsal bone and the center of the heel). It is important to start the exercises in a sitting position and then make the exercises more difficult by standing with both feet or one leg up. The position and intensity of training should be adjusted individually to the child²³.

The positive effect of SFE exercises is confirmed by the research of J.J. Faser, J. Hertel, and the research of S.K Lynn, R. A. Padilla, K. Tsang^{24,25}. Both studies evaluated the effect of 4-week short foot exercises on the foot's motor functions and abilities. Research has shown that SFE used in the rehabilitation process has a positive effect on the muscles strength and functions of feet. Also the research carried out by E. Mulligan and P. G. Cook showed that SFE exercises have a positive effect on static and dynamic functions of the foot²⁶.

Very often, plano-valgus feet are accompanied by reduced Achilles tendon and the gastrocnemius muscles. In the treatment of plano-valgus and flat feet, N. M. Blitz et al. pay attention to exercises aimed at stretching the Achilles tendon. If a child performs only strengthening exercises, the results may not be satisfactory. It is important not to skip stretching exercises in the rehabilitation process.

Physiotherapeutic methods are recommended among children with pain or inflammation associated with plano-valgus feet. To reduce inflammation N. M. Blitz et al. recommend the use of cold compresses, in combination with rest and anti-inflammatory drugs²⁷. Also D. D. Matanowic et al. showed how important physical methods are in the treatment of foot defects in children. Although the authors emphasize that the basis of rehabilitation is kinesiotherapy, they do not

forget about physiotherapy. It is very important in removing inflammatory processes (thermotherapy, ultrasounds) and maintaining the effects of correcting the defect (electrotherapy). After surgery, physical procedures may contribute to faster recovery, reduction of pain, swelling and other postoperative complications²⁸.

The topic of discussion is the use of kinesiology taping in the treatment of flat feet. It is used to set the foot in the correct position. In the literature, the research results are indecisive. P. Balci et al. write about the positive effect of taping. The research was carried out on 10 boys aged about 8 years. After 4 weeks of using taping, the authors showed that the contact of the foot with the ground improved during applying the load on the limbs²⁹. On the other hand, the research of S. Priyanka and S. Murugan showed that use of kinesiology taping does not affect the rehabilitation process. They conducted their research on a group of 44 children. The group was randomly divided into two groups. In the first group, the correct taping was used in connection with kinesiotherapy and physical therapy. Whereas in the second group, kinesiotherapy and physical therapy were connected with apparent kinesiologytaping, which acted as a placebo. Although the effects of physiotherapy were positive in both groups, the authors did not notice any differences between the results. The effects were the same in both groups³⁰.

To maintain the effect of the exercises, supination insoles are used. One can be put in a shoe to keep the foot in the correct position and support the arches of the foot. However, it should be remembered, as M. Okoński writes, that there are no documented reports on the therapeutic effect of the insoles⁹. Used alone, without any other treatment methods, they will not treat the plano-valgus foot. Additionally, they may adversely affect the structure and function of the foot, because they "laze" the muscles and ligaments, leading to their weakening. When wearing insoles is connected with, for example, corrective exercises, they can help in treatment of plano-valgus feet¹⁷.

In their studies, K. Słonka and L. Hyla-Klekot selected three different methods for the treatment of plano-valgus feet and assessed effectiveness of these methods. The first method used corrective exercises, the second one used MEMO shoes, and the third one involved selecting individual shoe insoles. The research showed that corrective exercises had a significant, positive effect on the treatment the foot. The authors also proved that MEMO shoes and orthopedic insoles contributed to the improving foot stability. However, it should be remembered that all children who used MEMO shoes and orthopedic insoles had individually selected sets of exercises to be performed at home¹.

R. Hsieh, H. Peng and W. Lee confirm the effectiveness of short-term use of orthopedic insoles in children. After 12 weeks of using the insoles in children from the study group, pain in feet was reduced and their quality of life³¹ improved. The studies by K. Chen, Y. Chen, C. Yeh, C. Hsieh and C. Wang also confirm the positive effect of using orthopedic insoles. In children from the study group, insoles were used for 1 year. Based on their research, the authors suggest that orthopedic insoles should be used as a conservative treatment³².

4. Conclusions

Scientific research from the analyzed work shows that accurate and correct diagnostic examination is of great importance in the treatment of plano-valgus feet in children. The examinations should be carried out in various planes of the body, and in static and dynamic conditions^{1,14}. Performing tests should include both observational methods and the use of special diagnostic devices such as: plantoconturograph, podoscope, and pedobarographic mat^{1,7,14,15}. Additionally, if there is such a need, X-ray images are recommended for the observation of the bone structure¹⁴. To assess subjective symptoms, the authors use questionnaires or the visual analogue scale (VAS)¹⁶.

The analyzed studies show the role of physiotherapy in the treatment of plano-valgus feet in children. Among the examined children, the improvement was visible after the use of corrective exercises^{19, 20, 21, 22, 23, 26}. The best results were observed when corrective exercises were connected with the use of orthopedic insoles²¹. Physical therapy may additionally be used^{27,28} among patients complaining of symptoms such as pain or muscle cramps. This therapy not only has positive effects on pain relief, but also provides faster recovery.

Plano-valgus feet are a more common problem not only among children but also among adults. Parents or legal guardians should pay special attention to the proper development of the child, including the development of feet. If parents suspect a defect or any abnormal development of the child, they should see a doctor or a physical therapist. There are many diagnostic methods that will allow to detect the defect at an early stage. The earlier treatment and rehabilitation start, the faster a child recovers, without pain and problems related to abnormal development.

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