3 FOOT DEFORMITIES IN THE CONTEXT OF THE POSITION OF THE LOWER LIMBS AND PELVIS IN A PATIENT WITH A DERMATOLOGICAL DISEASE

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3.1 Introduction

Man is the only mammal that has mastered the function of bipedal walking. The formation of the curvatures of the spine, the high position of the general centre of gravity and changes in the foot must have entailed a number of changes in the arrangement of the entire skeleton. The latter (foot) is assigned important functions: support, cushioning and locomotion. Injuries, disorders of the structure or function of the feet can contribute to abnormalities of the higher segments. These abnormalities may manifest themselves not only in the incorrect position observed during the examination in statics (e.g. positioning of the feet in excessive external rotation in relation to the lower leg, dysfunctions of the forefoot, valgus position of the hindfoot), but also, as research indicates, may contribute to a change in the pattern of movement, e.g. gait. This, in turn, may be the cause of m.in pain reported by the patient, the appearance of previous degenerative changes. On the other hand, the position of the feet while standing and walking may be conditioned by the specific anatomical structure of the lower limbs above the ankle joints. This may explain why some people walk with their feet outwards and others inwards (excessive femoral sprain, shin torsion). It is also worth considering the position of the other elements of the lower limb in the assessment of the feet.

3.1.1 Development and physiological changes in the lower limb

From the moment of conception, a number of changes take place in the body of a growing little person. The three basic germ layers of the endoderm, ectoderm and mesoderm develop the entire human body. From the latter develop limbs. Limb primordia appear in the 3rd-4th week of pregnancy and joints in the 6th week of pregnancy. The lower limbs at birth account for about 15% of body length, and at the time of reaching skeletal maturity they account for 30% (Dormans et al., 2019; Napiontek, 2021, Bartel 2004). Along with changes in the length of the limbs, physiological changes in the position of the entire lower limbs are also observed. These changes concern, m.in the femoral angle inclination, the femoral antetorsion and the tibiofemoral angle, which change with the growth of the limb. The femoral angle inclination after birth is about 135°, successively by the end of the 2nd year of life it increases to 150°, and then at the end of growth it reaches the value of about 125° (Zukunft-Huber, 2013).

According to other researchers, the femoral angle inclination in a newborn is 150° and begins to decrease with static load (Bochenek et al. 1968; Platzer, 1997). The average value of the femoral antetorsion after birth is about 30-40° and gradually decreases as the child grows to reach a value between 8 and 14° in adulthood (Gulan et al., 2000; Scorcelletti et al., 2020). On the other hand, the tibiofemoral angle from birth to the first year of the child's life shows significant varus (value greater than 175°), between 1.5 and 2 years of age the lower limbs position themselves neutrally, and then between 2 and 3 years of age this angle changes to values indicating the position of the lower limbs in valgus (value less than 175°) so that at school age, i.e. around 7 years of age, it can be self-corrected and remain in the neutral position (Dormans et al., 2019; Zukunft-Huber, 2013). In the case of the foot, these changes concern the length, the height of the longitudinal arch, the position of the hindfoot. The foot is the first structure to undergo an upward leap of puberty. In an adult, the length of the foot is about 15% of the body length. The most intense increase in foot length is observed in the first three years of the child and during puberty. The change in the appearance of the longitudinal arch depends on many factors, among which the following are remodelling and disappearance of adipose tissue (Spitzy's fat pad) located in the medial part of the foot and histological and functional changes in the connective tissue (the construction of collagen, which has a much lower number of connections). As the available literature indicates, the formation of the longitudinal arch is influenced by many factors such as: age, sex, race, footwear worn and age when the wearing of shoes began (Razeghi et al., 2002; Hoey et al., 2023, Napiontek, 2021). According to Kapahdi, there are 3 types of feet, the specific structure of which may predispose to the occurrence of certain pathologies within the feet. These include: the Greek foot (the second toe is the longest, and the big toe and the third toe are of similar length), Egyptian (the longest is the toe and subsequent toes are characterized by shorter and shorter length, ending at the fifth toe) and Polynesian (or square – at least the first three toes are of similar length). As the most susceptible to the occurrence of deformities in the forefoot, the author indicates the Egyptian foot, which may predispose to the occurrence of such deformities, such as: hallux valgus, hallux rigidus (Kapandji , 2014).

3.1.2 Links between disorders of foot structure or function and effects on higher elements

The dynamic development of science cites a number of studies indicating the existence of connections between tissues. Different authors present these connections in different ways. It seems that the foot, which is the first link in the biokinematic chain of the lower limb, may be of key importance. Studies indicate that the presence of abnormalities within the foot (foot deformities, as well as injury) may be associated with previous degenerative changes, pain, changes in body posture, but also with a decrease in the broadly understood quality of life. In the available literature, there are reports indicating links between disorders of the structure or function of the feet and their potential impact on higher segments. However, there is no consensus among researchers and the potential impact should be considered on a case-by-case basis. Researchers indicate that the presence of hallux valgus can often be associated with previous degenerative changes in the knee joint, patellofemoral pain, greater internal rotation in the hip joint, higher Q angle values, greater hindfoot valgus, reduced flexibility of the iliotibial band, higher anteroposterior body inclinations and an increased risk of degenerative changes in the spine compared to the control group. Another abnormality in the foot that can result in a potential impact on the higher segments is the presence of the toe limitus. Its occurrence results in reduced internal rotation in the hip joint, a different range of motion within the ankle joint and pelvis during gait compared to the control group. Torsion injuries in the ankle joint, on the other hand, can result in problems related to pain in the spine and knee joint, and the occurrence of flat feet can often be associated with knee pain, pain in the lumbar spine and more frequent occurrence of degenerative changes in the hip joints. Therefore, it seems that covering the patient with a broadly understood holistic assessment is crucial. Below is a summary of selected problems occurring in the forefoot and their potential impact on other elements in the body.

Table 6 Selected foot disorders and potential impact on other elements in the body – a review of the literature.

Author	Title	Journal	The sample	Dysfunction in the foot or other part of the lower limb	Effects on other parts of the body
Kaya, D., Atay, O. A., Callaghan, M. J., Cil, A., Çağlar, O., Citaker, S., Yuksel, I., & Doral, M. N. (2009)	Hallux valgus in patients with patellofemoral pain syndrome	*Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*	99 subjects (24 men, 75 women); average age 43 years	Hallux valgus	People with hallux valgus are more likely to have patellofemoral pain
Steinberg, N., Finestone, A., Noff, M., Zeev, A., & Dar, G. (2013).	Relationship between lower extremity alignment and hallux valgus in women.	Foot & ankle international	49 women (25 women with hallux valgus, 24 women without hallux valgus); average age between 51 and 80 years without and with hallux valgus	Hallux valgus	Women with HV are characterized by significantly higher internal rotation in the hip joint, higher values of the Q angle, higher values of the range of motion in the ankle joint (flexion and extension) and in the joint in I MTP. In addition, these women are characterized by a more valgus rearfoot position compared to the control group.
Kim, S. J., You, K. J., & Jung, D. Y. (2018).	Between-side comparisons of iliotibial band flexibility and the tibial torsion angle in subjects with an asymmetric hallux valgus angle	Journal of Musculoskeletal Science and Technology	14 subjects (the necessary number calculated on the basis of the power of the test) (5 women 10 m). Average Age 33.0±10.3 years	Hallux valgus	The flexibility of the iliotibial band was significantly lower on the side with the greater hallux valgus. The tibial torsion angles did not differ

					significantly between the two sides.
Roddy, E., Zhang, W., & Doherty, M. (2008)	Prevalence and associations of hallux valgus in a primary care population	*Arthritis Care & Research: Official Journal of the American College of Rheumatology*	Questionnaire conducted on a group of 1,194 people with hallux valgus, mean age 63.2±13.4, 2,674 people from the control group 54.5 ±14	Hallux valgus	Hallux valgus is associated with the occurrence of osteoarthritis, knee pain
Kozáková, J., Janura, M., Svoboda, Z., Elfmark, M., & Klugar, M. (2011).	The influence of hallux valgus on pelvis and lower extremity movement during gait.	Acta Gymnica	17 subjects (6 patients with bilateral HV deformity – mean age 57.8 ± 5.64, 11 patients without hallux valgus deformity – mean age 50.7 ± 4.41)	Hallux valgus	Subjects with bilateral hallux valgus deformity differ significantly: in the achieved range of motion in the ankle joint (greater plantar flexion during the St phase (LR), lower dorsiflexion during the St phase), the range of motion of extension in the knee joint (phase swing) and the range of motion in the hip joint. In addition, significantly lower values of pelvic mobility in all planes during gait were noted compared to the subjects from the control group.
Shih, K. S., Chien, H. L., Lu, T. W., Chang, C. F., & Kuo, C. C. (2014).	Gait changes in individuals with bilateral hallux valgus reduce first metatarsophalangeal loading but increase knee abductor moments	Gait & posture	12 women with bilateral hallux valgus deformity (mean age 45.5 ± 9.2 and 12 women without this abnormality; mean age 46.8 ± 9.8 years	Hallux valgus	In subjects with hallux valgus deformity, lateral displacement of COP away from the first metatarsophalangeal joint (MPJ) was found. This strategy increased abduction moments in the knee, an index closely correlated with medial load in the knee, and a predictor of the onset and progression of

					medial osteoarthritis of the knee
Fotoohabadi, M., Spink, M. J., & Menz, H. B. (2021).	Relationship between lower limb muscle strength and hallux valgus severity in older people.	The Foot	157 people (99 women and 58 men) aged between 65 and 91. Hallux valgus deformity was found in 54 subjects, while no deformity was found in 103 patients.	Hallux valgus	The higher the value of hallux valgus, the lower the force hallux plantar flexion muscles
Omae H., Ohsawa T., Hio N., Tsunoda K., Omodaka T., Hashimoto S., Ueno A., Tajika T., Iizuka Y., Chikuda H.	Hallux valgus deformity and postural sway: A cross-sectional study.	*BMC musculoskeletal disorders*.	169 people (106 female, 63 male) median age: 66.0 ± 12.4 years. Hallux valgus deformity was found in 44 subjects, while no deformity was found in 125 patients.	Hallux valgus	People with hallux valgus deformity are characterized by significantly greater the anteroposterior postural sway than the control group. The muscle mass of the lower limbs in the group with hallux valgus was significantly lower than in the group without hallux valgus.
Hsu, T. L., Lee, Y. H., Wang, Y. H., Chang, R., & Wei, J. C. C. (2023	Association of Hallux Valgus with Degenerative Spinal Diseases: A Population-Based Cohort Study	International Journal of Environmental Research and Public Health	Retrospective cohort study (from 01.01.2000-31.12.2015). 1000 people with hallux valgus deformity and 1000 people from the control group	Hallux valgus	The researchers noted a relationship between the presence of hallux valgus and an increased risk of developing degenerative spinal diseases (1.7-fold higher risk), a higher risk of spondylosis and intervertebral disc diseases.
Lafuente, G., Munuera, P. V., Dominguez, G., Reina, M., & Lafuente, B. (2011)	Hallux limitus and its relationship with the internal rotational pattern of the lower limb	Journal of the American Podiatric Medical Association	80 subjects (45 patients with a slight stiff toe and 35 controls) aged between 20 and 45 years	Hallux rigidus	People with hallux rigidus had significantly less internal rotation in the hip joint. The greater the rotation restriction, the more limited the movement of the dorsiflexion of the big toe.

Cansel, A. J., Stevens, J., Bijnens, W., Witlox, A. M., & Meijer, K. (2021).	Hallux rigidus affects lower limb kinematics assessed with the Gait Profile Score.	Gait & Posture,	15 patients with hallux rigidus (mean age 63.7 ± 10.5 years and 15 controls (59.1 ± 5.1 years).	Hallux rigidus	The presence of hallux rigidus affects the kinematics of the lower limbs, where compensation occurs on many levels.
O'Leary, C. B., Cahill, C. R., Robinson, A. W., Barnes, M. J., & Hong, J. (2013)	A systematic review: the effects of podiatrical deviations on nonspecific chronic low back pain	Journal of back and musculoskeletal rehabilitation	Literature review	Various abnormalities and deformities within the foot	Overpronating the foot may be associated with low back pain.
Brantingham, J. W., Lee Gilbert, J., Shaik, J., & Globe, G. (2006)	Sagittal plane blockage of the foot, ankle and hallux and foot alignment-prevalence and association with low back pain.	Journal of chiropractic medicine,	100 people with chronic and 104 people without lower back pain between the ages of 18 and 45.	Limitation of mobility in the ankle joint	Limitation of dorsiflexion is associated with ailments of the lower spine
Friel, K., McLean, N., Myers, C., & Caceres, M. (2006)	Ipsilateral hip abductor weakness after inversion ankle sprain	Journal of athletic training	23 subjects with unilateral chronic ankle sprain (mean age 26.65 ± 8.35 years)	Ankle sprain	On the ankle sprain side, the researchers noted reduced hip abductor muscle strength and a smaller range of plantar flexion in the ankle joint.
Powers, C. M., Ghoddosi, N., Straub, R. K., & Khayambashi, K. (2017).	Hip Strength as a Predictor of Ankle Sprains in Male Soccer Players: A Prospective Study.	Journal of athletic training,	185 men from football clubs in various age categories aged between 14 and 34. In 25 people, non-contact ankle sprain was recorded, while the rest were in the control group.	Ankle sprain	Reduced isometric force of hip abductors predisposes male soccer players to non-contact lateral ankle sprain
Theisen, A., & Day, J. (2019).	Chronic Ankle Instability Leads to Lower Extremity Kinematic Changes During Landing Tasks: A Systematic Review.	International journal of exercise science	Review Study - The purpose of this study was to provide a systematic review of the studies done on chronic ankle instability (CAI) and lower limb kinematics during landing tasks. The 6	Chronic ankle instability	Subjects with chronic ankle instability during landing tasks were found to have reduced knee flexion compared to the control group. Reduced knee flexion has been

			studies identified involved 338 people.		shown to be a key risk factor for non-contact knee injuries.
Pawłowska, K., Pawłowski, J., Mazurek, T., Piotr, A., Kołodziej, Ł., & Grochulska, A. (2019)	Feet deformities in patients with hip osteoarthritis	Medical Research Journal	60 people with osteoarthritis of the hip aged between 52 and 84. The control group consisted of 32 people without osteoarthritis of the hip aged 50-74 years.	Shape of the plantar part of the feet	In people with osteoarthritis of the hip, lower values of the Wejsflog index, lower values of the Clarke angle and higher values of the hallux valgus angle were noted.
Amraee, D., Alizadeh, M.H., Minoonejhad, H. et al.(2017)	Predictor factors for lower extremity malalignment and non-contact anterior cruciate ligament injuries in male athletes	Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA	53 men aged 25±4.83 years after complete anterior cruciate ligament injury	8 measurements of lower limb alignment were taken: Craig test, hip rotation measurement, foot-thigh angle, knee joint position, Q angle, navicular bone drop test, ankle dorsiflexion range,	Limitation of dorsiflexion in the ankle joint, internal rotation in the hip joint and a greater angle of anterversion are significant factors influencing the increased risk of non-contact ACL injury
Dahle, L. K., Mueller, M., Delitto, A., & Diamond, J. E. (1991).	Visual assessment of foot type and relationship of foot type to lower extremity injury	Journal of Orthopaedic & Sports Physical Therapy	77 athletes (68 men and 7 women) aged 13-18 years	Pronating/Supinating /Neutral Foot Positioning	Athletes with an overly pronating or supinating foot position may be more prone to knee pain than athletes with an overly prone foot position.

3.1.3 Other factors affecting the position of the lower limbs

When assessing the position of the lower limbs, it is worth remembering that the way of standing and walking may be conditioned not only by dysfunctions located within the foot, but also by the specific anatomical structure of the lower limbs above the ankle joints. An example is femoral anteversion, the size of which changes with growth and reaches a physiological value of 10°-15° around the age of 12. In the case of excessive femoral anteversion, both the kneecap and the feet will point inwards when walking (Harris, 2013). Femoral anteversion usually runs in families and is observed in both limbs. As the literature indicates, its presence may be associated with the presence of various functional problems, including more frequent falls, faster fatigue when covering longer distances, sitting in the "W" position. Some authors emphasize that the presence of femoral anteversion may affect the occurrence of symptoms such as: pain located on the front part of the knee, patellar instability, femora-acetabular impingement and labral tear (Leblebici et al., 2019; Qiao et al., 2022; Eckhoff et al., 1996; Scorcelletti, 2022). Other researchers indicate that children with femoral anteversion are characterized by worse body balance (Tuncer et al., 2019). Others find links between flat foot and femoral anteversion in children between the ages of 3 and 6 (Zafiropoulos et al., 2009). As indicated by the literature, the presence of excessive femoral anteversion is associated with an increased risk of non-contact ACL injury. In the opposite situation, i.e. in femoral retroversion, patients will be characterized by the opposite pattern. (Lerch et al., 2022). Patients with femoral retroversion are characterized by reduced internal rotation in the hip joints. Pain is often reported in the anterior part of the hip joint due to femoroacetabular impingement (Meier et al.,2022). In addition, research conducted by Tsagkaris et al. indicate that the posterior position of the femoral head relative to the axis running through the condyles may affect gait and running patterns (Tsagkaris et al., 2024).

With this information in mind, try to look at the position of your feet in a slightly broader way, taking into account the position and the impact of one element on another.

3.2 Foot disorders – epidemiology

In adults, abnormalities and pain in the feet are a common problem. Pain in the foot, depending on the literature, is observed from 13%-36% of the respondents. It is more often observed in women, in obese people (BMI > 30.0 kg/m²). These ailments tend to intensify with age. In two large cohort studies conducted on Caucasians, pain appeared from 13% (Chingford 1000 Women Study) to 36% (Johnston County Osteoarthritis Project). In these recent studies, the frequency of pain in Caucasians compared to African Americans. The prevalence in these groups was comparable (35% to 36%, respectively). The least frequent pain was reported in Asians (Gates et al., 2019).

The most common abnormalities in the forefoot include hallux valgus, hallux rigidus, hammer toes, calluses (Nix et al., 2010). Their frequency of occurrence, depending on the literature, is as follows: hallux valgus 23% (and increases with age – after the age of 65 - 35.7%), hammer toes 8,9%, rigid painful toe (it is believed to affect 1% of people over 30 years of age). Research indicates that the presence of these abnormalities may affect quality of life, may be associated with the occurrence of pain, reduced quality of functioning and may create difficulties in choosing comfortable footwear (DiGiovanni et al., 2018; Nix et al., 2010; Şaylı et al., 2018). Another equally common dysfunction within the foot is flat feet. Salinas-Torres, V. M. et al. (2023) conducted a systematic review of the literature on the prevalence of flat feet. They analysed 12 publications including 2509 cases of flat feet in the assessment. The results of their research indicate that flat feet are more common among males, younger individuals (3-5 years, 11-17 years), Asian and obese. Female and Caucasian are less associated with flat feet (Salinas-Torres et al., 2023). The literature indicates that one of the most common injuries in the ankle joint is inversion torsion injury of the ankle joint. It is estimated that every thousandth person suffers an injury during the day due to ankle sprains or dislocations and about 6% of young representatives of athletes (Doherty et al., 2014; Bilewicz et al., 2012)

3.2.1 Consequences of foot abnormalities

Abnormalities in the feet can affect various areas of life. The literature on the subject indicates that abnormalities within the foot may be associated with: the occurrence of pain, reduced quality of life (López-López et al., 2018; Jalali et al., 2021; Menz et al., 2006), functional limitations (Badlissi et al., 2005; Nix et al., 2012), problems with choosing the right footwear (Menz et al., 2005; Dawson et al., 2002), cosmetic problems (Menz, 2022), deterioration of gait quality and in older people with an increased risk of falling (Menz, 2006). The most frequently mentioned abnormalities within the foot include pain, longitudinal and transverse flat feet, excessive pronation position of the foot, forefoot anomalies (hallux valgus, hammer toe, calluses, hallux rigidus).

3.3 Diagnostic tests used in the assessment of foot shape

In clinical practice, the gold standard for diagnosing foot and lower limb dysfunctions is an X-ray. In physiotherapy practice, podoscopes can be used to assess the shape of the plantar assessment of the feet. After the examination, information is obtained on: the length and width of the foot, the quality of the longitudinal and transverse arch, the position of the big toe and the fifth toe. To complement the foot alignment test, it is worth using the commonly used and highly reliable FPI (Foot Posture Index) Test (Oleksy et al., 2010; Redmond et al., 2008).

3.3.1 Assessment of the shape of the rates using the FPI questionnaire

This test is a simple and quick test that does not require any additional equipment. This examination evaluates the alignment of six elements (palpation of the head of the talus, curves below and above the lateral malleolus, position of the calcaneus, convexity of the ankle-navicular joint, medial longitudinal arch of the foot, adduction/abduction of the forefoot relative to the hindfoot). For each test element, the tested person receives a certain number of points, and the sum of the points obtained allows the foot to be classified into one of the categories. A five-point scale (-2 to +2) was adopted to assess the position of each of the evaluated elements. Negative values indicate a more supinated position of the element, while positive values indicate a pronation position. In the case of a neutral position, the subject receives 0 points. The sum of the points qualifies the assessed foot to one of five categories: correctly set foot (from 0 to +5 points), slight pronation foot (from +6 to +9 points), significant foot pronation (from +10 to +12 points), slight supination rate (from -1 to -4 points), severely supinated foot (from -5 to -12 points). The following is an assessment of the individual elements of the foot:

Table 7 FPI questionnaire – own source based on Oleksy et al. 2010

Patient's starting position	Therapist's starting position	Rated item	Supination setting		Neutral	Pronation Positioning	
			-2 points	- 1 point	0 points	+1 point	+2 points
Habitual standing, arms alongside the body	The therapist in front of the patient, places the thumb and index finger on the lateral and medial sides of the talus head	Palpation of the head of the talus*	talus head clearly palpable on the lateral side and imperceptible on the medial side;	talus head palpable after side and faint on the side of the medial	talus head palpable similarly on the lateral and medial sides	talus head palpable after medial side and faintly felt on the lateral side	talus head clearly palpable on the medial side and imperceptible on the lateral side
	The therapist stands behind the patient, observes the appearance of the line above and below the lateral ankle	Curves above and below the lateral ankle	curve below the lateral ankle flat or convex	curve below the lateral malleolus concave, but flatter than above the ankle	curves above and below the ankle the same	curve below the lateral ankle more concave than the curve over the ankle	curve below the lateral ankle clearly more concave than above the ankle
	The therapist stands behind the patient, assesses the course of the calcaneal axis in relation to the axis of the lower leg	Calcaneal alignment	more than 5° varus;	between the correct setting a 5° varus	correct (vertical) alignment calcaneus	between the correct setting and 5° valgus	more than 5° valgus
	The therapist observes the ankle-navicular joint area.	Convexity in the ankle-navicular joint area (TNJ)	ankle-navicular joint area clearly concave	ankle-navicular joint area slightly concave	ankle-navicular joint area flat	ankle-navicular joint area slightly convex	the TNJ area is clearly convex
	The therapist assesses the height of the medial longitudinal arch of the foot	Arch of the medial longitudinal arch	a high, clearly curved arch near the end of the medial arch	the arch is moderately high, slightly sharp backwards	arch of the correct height, gently	lowered arch with flattening in the middle parts	arch strongly lowered with a clear flattening in the middle part

					bent along the entire length		
	The therapist stands behind the patient, assesses the position of the forefoot in relation to the hindfoot.	Forefoot adduction/abduction in relation to the hindfoot	fingers on the side invisible/ fingers on the medial side clearly visible	fingers on the medial side more visible than the fingers of the side	fingers on the lateral and medial sides equally visible	fingers on the side more visible than the fingers of the medial side	fingers on the medial side invisible/ fingers of the lateral side clearly visible

*Palpation of the talus bone – to palpate the head and neck of the talus, place the index finger of one of your hands transversely on the front part of the ankle joint, directly in front of the tibia. In this position, your finger is on the neck of the talus. By placing your middle finger against your index finger, you will place it directly on the navicular bone. Notice how clearly the head of the talus protrudes medially during the turning movement and to the lateral side during the foot inversion movement (Jorritsma, 2004).

3.3.2 Arch Assessment

Feiss line test

This test is used to assess the height and flexibility of the longitudinal arch. The patient sits on a couch. The therapist marks three points on the medial side of the foot: the top of the medial malleolus, the tuberosity of the navicular bone and the head of the first metatarsal bone. Then the patient stands on both feet, evenly distributing the weight of the body on both feet, the therapist again marks the tuberosity of the navicular bone. Correctly in the unloading position, the tuberosity of the navicular bone is located on the Feiss line. A positive test result is evidenced by a marked decrease in the tuberosity of the navicular bone below the Feiss line after the patient assumes a standing position. This indicates functional flat feet. The location of the navicular tuberosity below the Feiss line, both in relief and in load, indicates permanent flat feet.

3.1a 3.1b

Picture 3.1 a, b. Feiss line test – how to perform it

Functional and structural flat foot differential test

This test allows you to differentiate functional flat feet from structural flat feet. The subject stands on both feet, stands on tiptoe, then sits with his lower legs and feet hanging freely. The therapist visually assesses the height of the arch. Longitudinal flat feet are considered functional, resulting from muscle and ligament weakness if the medial arch, lowered or abolished while standing, appears in a sitting position or when climbing on toes. Longitudinal flat feet are considered structural if no change in the shape of the arch is noticed during the test, despite the change in position.

3.2 a 3.2 b 3.2 c

Picture 3.2 a, b, c Test differentiating between functional flat feet and structural flat feet

Longitudinal arch index

This test allows you to assess the longitudinal arch. The subject stands and then sits on a chair. The therapist stands next to the subject. The therapist measures the height of the foot in the middle of its total length and the length of the foot without the toes. Then divide the height of the foot by the length of the toeless foot. The correct value of the index is about 0.33 in a standing position and 0.36 in a sitting position and is similar in each age group.

Picture 3.3 Longitudinal arch index

Hallux lift test (Jack test)

This test is used to diagnose the cause of longitudinal flat feet. The patient sits on a chair, feet resting on the ground. The therapist passively raises the big toe towards extension in the metatarsophalangeal joint of the big toe. This test uses a windlass mechanism. If the cause of longitudinal flat feet is the lowering of the navicular and medial cuneiform bones , passive extension of the big toe causes the elevation of the arch of the foot. However, if the lowering of the medial arch is due to an incorrect position of the talus, no changes will be observed. The windlass mechanism does not create enough leverage to lift the navicular bone, as it is blocked by the head of the talus being too vertical.

Picture 3.4 Hallux lift test (Jack test)

Navicular Alignment Test

This test is used to assess the longitudinal arch. The patient stands in a tandem position (the heel of the forward leg touches the toes of the crooked leg). The therapist marks three points on the foot: the head and metatarsal bone, the tuberosity of the navicular bone and the point above the Achilles tendon at the top of the lateral ankle. Then he measures the angle between the line connecting the head of the metatarsal bone and the tuberosity of the navicular bone and the tuberosity of the navicular bone and the point above the Achilles tendon at the level of the apex of the lateral malleolus. The axis of the goniometer is placed over the tuberosity of the navicular bone, and one arm aims at the head of the first metatarsal bone, while the other at the point above the Achilles tendon at the level of the top of the lateral malleolus. In the case of a correct formation of the longitudinal arch, the described angle is close to zero.

Picture 3.5 Navicular alignment test

3.3.3 Hindfoot tests

Coleman Block Test

This test is used to assess the correctness of varus foot. The patient is in a standing position, the therapist places a 2.5 cm high wooden block under the lateral edge of the patient's foot. The metatarsal bones I-III remain unsupported. If, after placing the pulley, the heel returns to the correct position or positions itself valgus, the deformation of the hindfoot is functional and results from permanent disorders at the forefoot level (Bac et al., 2022).

3.6 a 3.6 b

Picture 3.6 a, b Coleman test – how to perform it

Symptom of too many fingers

This test is used to assess the abducted flat-valgus foot. The patient stands in a habitual position, the therapist observes the position of the feet. In a normal situation, when viewed from behind, the fifth toe and half of the fourth toe are visible on the lateral side of the heel. A positive test result is indicated by the position of the forefoot in excessive abduction, the position of the tibia in excessive external rotation and the position of the calcaneus in valgus. The therapist looking from behind sees more fingers on the lateral side.

Looking from the back, on the side of the heel, how many toes do you notice?

Picture 3.7 Symptom of too many fingers

Tiptoe test

This test is used to assess the function and efficiency of the posterior tibial muscle. The patient stands with hip-width apart facing the wall. He stands on the toes of both feet, and the therapist observes the position of the hindfoot. Then he repeats the same task but standing on the toes of one of his feet, trying not to bend his knee, torso and not to rest his toes against the wall. He repeats the same task on the other foot. If no symmetrical hindfoot inversion is observed during the toe test of both feet, it indicates insufficiency of the tendon and the posterior tibialis muscle. What change did you observe in the position of your hindfoot when standing on the toes of both feet? Was the change symmetrical?

Picture 3.8 a, b, c Tiptoe Stand Test

3.3.4 Forefoot tests

Morton's test (Gänsslen's grip)

This test is used to provoke forefoot pain. Patient in the position of lying backwards on the couch. The therapist stabilizes the foot from the medial side with one hand. With the other hand, the therapist squeezes the forefoot at the level of the first and fifth metatarsal bones. If the patient reports pain in the area of the heads of the metatarsal bones during the test, it may indicate the presence of Morton's neuralgia or severe transverse flat feet. In the case of neuralgia, pain may radiate to adjacent fingers.

Picture 3.9 Morton test – how to perform it

Navicular Bone Drooping Test

This test is used to assess overpronation of the forefoot. The patient stands in a habitual position. The therapist marks a point at the level of the tuberosity of the navicular bone with a marker, then measures the distance of this point from the ground. Then the patient puts the foot in a neutral position and the therapist again takes the measurement from the ground to the marked point. If the difference between the measurements is greater than 10 mm, it indicates excessive pronation of the forefoot

Picture 3.10 a Navicular Bone Drooping Test - Habitual Position

Picture 3.10 b Navicular Bone Drooping Test – Neutral Position

3.3.5 Muscle flexibility tests

Silfverskiöld test

This test is used to assess the elasticity of the gastrocnemius and soleus muscles. Patient in a backward lying position. The therapist, standing on the patient's side with one hand, stabilizes the area just above the knee joint. The other hand covers the hindfoot area, resting the plantar side of the foot against his forearm and placing the foot in a neutral position. In the case of deformities, e.g. flat-valgus foot, the therapist corrects to a neutral position. Then he performs passive dorsiflexion in the ankle joint. Maintaining the above position, he bends the patient's limb at the knee joint to an angle of 90° and again performs maximum passive dorsiflexion of the ankle joint. In the case of normal flexibility of the triceps calf muscle, the dorsiflexion range is approx. 10° in the position of the straight knee joint and 20° in the flexion position of the knee joint.

Picture 3.11 a Silfverskiöld test – assessment of the triceps calf muscle

Picture 3.11 b Silfverskiöld test – assessment of soleus muscle

3.3.6 Tests to assess the dynamics of foot and lower limb work

Pronation test

This test is used to assess the dynamics of the foot and the entire lower limb during the transfer of body weight to the supporting limb. The subject stands in a small step and tries to detach the heel of the crooked leg and shift the weight of the body from the leg to the forward leg. A physiological reaction during the transfer of body weight to the forward limb (due to the structure of the joint) is the inclination of the calcaneus inwards, which forces medial rotation of the talus. This, in turn, allows pronation to move. The presence of this movement triggers movement within the lower leg bone and further on the femur (Earls J. et al., 2017).

Picture 3.12 a, b, c, d Pronation test – how to perform it

Supination test

This test is used to assess the dynamics of the foot and the entire lower limb during the supination movement. Subject in a small lunge position. The examined leg is positioned in front. The patient tries to perform a lunge movement combined with limb rotation and external pelvic rotation with the crotch leg. From the side, from the tested side, the therapist observes the movement of the fibula combined with the external rotation of the calcaneus (on the side of the examined leg – right) (Earls J. et al., 2017).

Picture 3.13 a, b, c Supination test – how to perform the test

Squat Test

This test is used to assess the movement control of the entire lower limb. Subject in a habitual standing position. The task of the subject is to perform 1/4 of the squat. The patient bends the lower limbs in a triarticular manner, trying not to lift the feet off the ground, the knees do not exceed the line of the toes. From the lateral side of the patient, the therapist observes mobility in the heel and lateral ankle area. He also pays attention to the quality and quantity of the movement performed. Physiologically, as a result of the weight of the body and the forces acting there, the calcaneus should retract. Observe how your knees position during the examination? How do the tuberosities of the tibia align? Do they "escape" inside? Do you notice any asymmetry in the work between the knees? Looking at the examined person from the side, observe what range of motion in the ankle joint is achieved by the examined person on the right and what range of motion on the left side? Do you notice any asymmetries?

Picture 3.14 Squat test

3.3.7 Assessment of the lower limb in the context of foot position

Craig's test

This test is used to assess the anterior/posterior tilt of the femoral neck. patient in forward lying position. The therapist bends the examined limb to an angle of 90° at the knee joint, with the other hand palpates the greater trochanter area** of the femur on the examined side. Then the therapist performs a slow movement of internal and external rotation in the hip joint, looking for the position in which the trochanter is most palpable. The result of the test is the value of the angle between the axis of the lower leg and the vertical line. In adults, this angle should be between 8 and 15° of internal rotation. Values lower than 8° indicate that the femoral head is positioned backwards in relation to the axis running through the condyles (retroversion). Values greater than 15° indicate that the femoral head is in an anteroversion.

Picture 3.15 Craig's test – how to perform it

** The greater trochanter lies a hand's width from the iliac crest downwards and is the most laterally located bone structure in the hip joint area. The position of the greater trochanter is often visible in a standing position, when the patient performs an abduction movement with one of the legs. Directly above the trochanter and below the iliac crest, a depression (buttock fossa) is visible. In addition, ask the subject to alternate the movement of external and internal rotation – you will easily notice and feel the movement of the greater trochanter of the femur (Jorritsma, 2004).

Test - foot-femur angle

This test provides an indicative assessment of torsion in the shins. Test subject in the supine position, limbs flexed to a 90° angle at the knee and ankle and shin joints. The patient's feet placed in an intermediate position between valgus and talus. The angle included between the long axis of the thigh and the axis of the foot determined by the second radius is evaluated. Under normal conditions, the foot should be twisted outward by 10°-20°.

Picture 3.16 Test - foot-femur angle – incorrect result

3.4 Assessment of the shape of the plantar part of the feet

The shape of the plantar part of the feet can be examined by making a print of the plantar part of the foot. An imprint of the plantar part of the foot can be obtained in several ways. One of them is the imprint of the sole part of the foot previously painted with paint on paper. On the other hand, in clinical trials, an electronic (computer) print obtained during an examination with the use of a podoscan is more often used. Regardless of the choice of the form of the print, the result obtained allows for the determination of various indicators describing the shape of the plantar part of the feet, such as: foot length, foot width, longitudinal arch, transverse arch, position of the big toe and fifth toe. In the case of using subscanners, the diagnostic possibilities can be much greater and allow, for m.in, to cooperate with software for designing orthopedic insoles. Below are selected indicators that allow to assess the shape of the plantar part of the feet.

Picture 3.17 Method of determining the length of the foot

Foot length – is determined by measuring between the end of the longest toe and the most protruding part of the heel

Picture 3.18 How the width of the foot is determined

Foot width - is determined by measuring the widest part of the forefoot between the medially and laterally protruding point

Wejsflog Index – allows you to assess the transverse arch and reflects the proportion of length to width of the foot. Ideally, this ratio should be 3:1. It is assumed that values between 2.55-3.00 indicate a correct transverse arch. Values below this range indicate transverse flat feet (Kasperczyk, 2004)

Picture 3.19 The Clarke angle method

Clarke's angle - is the angle that is determined between the tangent of the medial edge of the foot and the line that connects the point of greatest depression and contact of the medial tangent with the edge of the forefoot. It is assumed that for adults, values between 42 and 54° indicate a correct longitudinal arch and above 55° indicate a hollow foot. Values between 31 and 41° indicate a decrease in the longitudinal arch, while values below 31° indicate a flat foot (Bac et al., 2020)

Picture 3.20 Method of determining the angle of hallux valgus (α) and varus of the fifth finger (β)

The hallux valgus angle α – is the angle that is determined between the tangent to the medial edge of the foot and the tangent led from the point at the widest point of the forefoot to the outer edge of the big toe. The norm for this angle is 0-9°. Values higher than 9° indicate hallux valgus.

The varus angle of the fifth toe β is the angle measured between the tangent to the lateral edge of the foot and the tangent led from the point at the widest point of the forefoot to the outer edge of the fifth toe. The norm for the beta angle is a value between 0 and 5°. Values higher than 5° indicate a varus position of the fifth finger.

3.5 Conveying unfavourable news

A visit to a specialist (doctor, physiotherapist) is a challenge for most people. For most of us, this can be associated with a lot of anxiety and stress. That is why it is so important to provide the examined person with a friendly atmosphere, a sense of comfort and security. Below are some sample tips that you may find helpful when you conduct the examination.

During the examination and therapy, try to provide as much comfort as possible, taking into account the sense of dignity and intimacy. In practice, this means:

- creating an appropriate space for the patient to freely prepare for the examination (changing room)
- ensuring comfort during the examination (separating the space with a screen, not answering the phone by the examiner)
- avoiding addressing the patient as "you." In Poland, we address an adult using the word "Mr.", "Mrs."
- referring to the other person with due respect
- avoid commenting on the appearance, lifestyle and worldview of the patient in question
- it is good practice during the examination to inform the patient about the activities being performed (e.g. in a moment I will conduct a mobility assessment of the sacroiliac joints)
- if monitoring is used - the patient's consent is required
- not to have third parties present during the examination (unless the examined person agrees)
- no sharing of medical records with non-medical personnel.

Sometimes during a visit, we have to convey unfavourable news to the person being examined. Unfavourable information to be conveyed poses a major challenge for both the communicator and the patient. From the patient's (client's) perspective, unfavourable information for the patient is any news that materially and adversely changes the patient's perception of his own future. Remember that receipt by the patient of inauspicious information is associated with great stress for him. You may encounter a variety of reactions from momentary surprise (shock), disbelief, denial to the release of emotions (crying, anger, anger, anxiety, fear). Each of us in difficult situations needs time to get acquainted with the new difficult situation as well as to accept the "new conditions". Remember that each of us reacts differently to difficult situations!

In conveying unfavourable news, pay attention to:

- the place, time and environment where this information is to be conveyed,
- try to speak calmly and confidently,
- avoid medical jargon incomprehensible to the patient. When conveying information, use clear and simple wording understandable to the patient,
- the therapist's body language is also the transmission of information - try to maintain eye contact, be sincere and empathetic,
- when sharing unhelpful news, try to divide it into smaller "portions",
- allow the patient to be emotional,
- express understanding,
- present a plan of action (treatment),
- ask if the information provided is understood by the patient

3.5.1 Example protocols for the transmission of unfavourable messages

If you find it difficult to send unfavourable messages, you can use specially prepared protocols for this purpose. Protocols organize how bad (difficult, inauspicious) news is transmitted. It is a kind of set of tips and hints for various situations that you may encounter. Communicating the news of a poor prognosis is difficult for both the patient and the person who conveys the news. Perhaps it will be easier for you to imagine this difficult situation and try to put yourself in the shoes of a patient who is just waiting for information.

One of the most commonly used protocols in medical communication is the SPIKES protocol according to Baile (Baile et al., 2000). It consists of six stages of unfavourable information communication, including the following parts:

- stage one - **Setting up** the interview, i.e. preparing the interview. Try to choose the right place to provide a sense of intimacy and security, reserve enough time for the patient only, if the patient wishes, involve someone from the immediate environment to be next to him, take a sitting position when talking to the patient, try to maintain eye contact.

- stage two – assessing the patient's **Perception.** At this stage of the conversation, try to ask open-ended questions about the patient's perception of their medical situation and their attitude to the problem they are facing. You may ask, "What have you been told about your medical situation so far?" or "How do you understand the reasons why we had an MRI?"

- stage three – obtaining the patient's **Invitation.** In this part of the dialogue, we find out to what extent the patient wants to obtain full information about their health. Some patients do not want to talk about test results. They prefer this news to be passed on to someone close to them. Questions may be helpful: „Would you like me to discuss the results of the study in detail?" or "Would you like me to give you all the information, or would you like to outline the results and spend more time discussing the treatment plan?"

- stage four – giving **Knowledge and information to the patient**. This is the stage in which we provide the patient with information about his or her health condition. Try to use simple, understandable vocabulary, avoid medical jargon, convey information in "small" portions, try to observe the patient to see if it is understandable to the patient, avoid excessive directness

- stage five – addressing the patient's **Emotions with empathic responses.** Try to understand what emotions the patient is struggling with, give the patient some time to get used to the new situation, show understanding for these emotions, react with empathy

- Stage six – **Strategy and Summary.** At this stage of the conversation, try to make sure that the information you provide is fully understood by the patient, and then present treatment options, provide simple and specific actions

3.5.2 Recommendations for the transmission of unfavourable information, including intercultural communication

In the Polish context bad news is communicated in a direct way. While the patient is offered possibilities of further treatment, it is made clear, their aim is to preserve the current state rather than improve it. Some health issues (e.g. fungal infections) are considered shameful for the patient. Even a discussion about them with a therapist makes the patient embarrassed. It is important to keep the conversation about these health issues as private as possible.

Intercultural communication recommendations:

- Physiotherapists should undergo training or workshops on cultural sensitivity and diversity. This can help them understand how cultural backgrounds can influence patients' perceptions of health, illness, and treatment.

- If there's a language barrier, it's essential to use professional interpreters or translation services to ensure accurate communication. Avoid relying on family members, as they may not provide unbiased translations or may not be fluent in medical terminology.

- Be mindful of nonverbal cues, such as body language and gestures, which can vary across cultures. What may be considered appropriate in one culture may be offensive or misunderstood in another.

- Take the time to build rapport with the patient before discussing sensitive issues. Establishing trust and a comfortable environment can encourage open communication.

- When discussing foot deformities and fungal infections, use clear and simple language to explain the condition, treatment options, and expected outcomes. Avoid medical jargon that may be confusing or intimidating.

- Some cultures place a high value on modesty and privacy. Observe the patient’s reactions and ensure that they are comfortable with the level of exposure required for examination or treatment.

- Encourage patients to share their concerns and preferences by asking open-ended questions. This allows them to express their thoughts and feelings without feeling rushed or pressured.

- Practice active listening to understand the patient's perspective fully. Validate their experiences and feelings and show empathy towards their concerns.

- Be prepared to adapt your approach based on the individual patient's cultural background and preferences.

- In some cultures, patients may prefer to be treated by healthcare professionals of the same gender. Respect these preferences whenever possible.

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