fizjoterapia polska
nr 3/2015 (15)

Ocena zachowania równowagi ciała u osób ze stopą poprzecznie płaską i związane z tym upadki

Evaluation of body balance in patients with transverse flat foot and the related falls

Sylwia Czesna[C,D,E,F,G], Jan W. Raczkowski[A,B]
Odział Kliniczny Rehabilitacji Pourazowej, Uniwersytet Medyczny w Łodzi, Polska/
Clinical Department of Post Traumatic Rehabilitation Medical University of Łódź, Poland

Streszczenie:
Wstęp. Stopa poprzecznie płaska to bardzo często występująca wada stopy, najczęściej spotykana u kobiet noszących obuwie na wysokim obcasie. Główną przyczyną jest niewydolność mięśniowo-więzadłowa stopy, która zwiększa ryzyko upadków, stanowiąc zagrożenie dla sprawności osób dorosłych i starszych. Zdolność zachowania równowagi wynika z prawidłowego funkcjonowania tzw. czucia głębokiego ciała człowieka, koordynacji psycho-ruchowej oraz mocnych mięśni. Osłabienie siły mięśniowej zwłaszcza kończyn dolnych zwiększa ryzyko zaburzenia równowagi, stanowiąc zagrożenie upadkiem. Nieodpowiednie przenoszenie obciążeń na stopę płaską dodatkowo utrudnia utrzymanie równowagi.
Materiał i metodyka. Badaniami objęto 28 pacjentów ze stopą poprzecznie płaską i 21 pacjentów z prawidłowym wysklepieniem stopy w wieku 52±11,5
Wyniki. Analiza badanych parametrów wykazała, że zaburzenia zachowania równowagi ze stopą poprzecznie płaską występuje w 68% (n=19) badanych, a tylko 32% (n=9) badanych mieściło się w normie. Natomiast z prawidłowym wysklepieniem stóp zaburzenia równowagi występuje u 29% (n=6) badanych, a 71% (n=15) badanych znajdowali się w przedziale normy.
Wnioski. W przeprowadzonych badaniach wykazano zaburzenie równowagi u osób ze stopą poprzecznie płaską 2:1 większą niż u osób z prawidłowym wysklepieniem stóp. Wyniki badań wskazują, że osoby ze stopą poprzecznie płaską są bardziej narażone na zaburzenia równowagi, których efektem są upadki.

Słowa kluczowe:
stopa poprzecznie płaska, równowaga, koordynacja ruchowa

Abstract
Introduction. Transverse flat foot is a very often occurring foot defect, the most common in women wearing high-heeled shoes. It is the most common cause of musculoligamentous foot failure, which increases the risk of falls, threatening the efficiency of adults and the elderly. The ability to maintain a balance results from proper functioning of the so-called deep sensation of the human body, psychophysical coordination and strong muscles. Muscle weakness especially of lower limbs increases the risk of imbalance, thereby jeopardizing the fall. Improper passing burden on a flat foot makes it more difficult to maintain balance.
Material and methods. The study included 28 patients with transverse flat foot and 21 patients with normal foot arch at the age of 52±11.5
Results. Analysis of the tested parameters revealed that disturbances to maintain the balance with the transverse flat foot occurs in 68% (n= 9) subjects, and only 32% (n=9) of the test was within the normal range. In contrast, in patients with a normal arch feet imbalance occurs in 29% (n=6) subjects and 71% (n=15) subjects were in the standard range.
Conclusions. In this study it was we demonstrated that imbalance in patients with transverse flat foot is of 2:1 higher than in patients with normal arch feet. The results show that people with the transverse flat foot are more vulnerable to imbalances which result in falls.

Key words:
transverse flat foot, balance, motor coordination

fizjoterapia polska
nr 3/2015 (15)

Introduction

The human foot is an important static-dynamic part the musculoskeletal system. On one hand, it is supporting element and in conditions of statics it enables balancing of the body in the spatial position; on the other hand it fulfills the role of the drive mechanism, sending the body propulsion in the course of locomotion [1]. The foot is stable and active, that is, one that in a very short period of time is ready to react and adapt to new unforeseen situation, along with the control attitude in one-legged position are basic skills to enable correct management in case of losing balance [2,3]. Body balance shall be determined in the organism ability to keep its body position without the aid of other of people, excluding the uncontrolled falls. Balance is also such an organism feature which allows it to come back to its state in the time of performing specific activities or after their completion [4,5]. In every human, the degree of development of the ability to maintain body balance depends on the individual, genetic and environmental determinants [6,7]. For the smooth functioning of movement a human needs the control system steering muscle tension and position of individual body parts and receptors that are responsible for deep feeling of human body [8].

The instability of the foot is the result of weakness or damage to the ligaments or muscles – it is expressed by many authors. Among others, Funk [9] and Holmes [10] indicates the dominant role of insufficiency of the tibialis posterior muscle and peroneus longus muscle. Huang, on the basis of the results of experimental studies conducted on foot models said that the most important stabilizer of the arches is plantar aponeurosis. In his opinion, damage to ligamentous structures, in particular of the plantar aponeurosis quickly leads to the development of flat feet. A similar view presents, among others, Deland [11,12]. However, these reports are opposite to the results of tests performed by Baxter [13] and Leach [14]. These authors found that after cutting the plantar aponeurosis, the height of the arches remained normal. The causes of disorders on ability to maintain body balance may result from imperfections of one of elements of the balance system functioning. Motor skills is the processes which develops from the moment of birth. The basis of physical activity is the ability to maintain balance while standing. Some natural preferences of using one side of the body more than the other occurs at the age of late childhood and determine lateralization of a man. This can lead to the habit of supporting one lower limb, and in the same time an excessive burden on the other. From the point of view of the biomechanics of the human movement, the ability to stabilize the vertical position is to minimize body sway (ie. rocking the body in such a way that the vertical projection of the center of body mass does not move beyond the anatomical limits of stability set by the area of foot base) [15,16]. Such rocking of body requires constant activity of the musculoskeletal system, the volatility in the tension of postural muscles. The special

contribution to this task make the shin muscles that allow movement in the ankle joint and an feet pressure on the ground. Maintaining a stable upright posture involves merging stimuli of the sensory systems: visual, vestibular and proprioceptive [17]. These stimuli are in fact the information to the central nervous system (controller) on deviations in displacement of the center of mass of the body from the setpoint. The nervous system in turn, through feedback, activates the motor system (an operating system) to carry out the task, ie. limiting rocking posture so that the vertical projection was inside the anatomical surface of the foothold [18]. No foot arch impedes the maintenance of a stable vertical posture. There are several different forms of flat feet. The most frequent is a static flat foot. It arises as a result of interaction of several factors:

- excessive body weight,
- excessive and long-term external burden,
- weakening joints and ligaments after various diseases.

So shaped foot is the result of disequilibrium in the relationship between the weight force, and functional capacity of active and passive foot stabilizer. Foot overload caused by the failure of its musculo-ligamentous system, leads to distortions, dysfunction and pain.

Aim of study

The following research problems have been formulated:

1. Does laterally flat foot affect maintaining balance in adults?
2. Does foot arch affect the risk of falls in adults?

Material and methods

The clinical material was a group of 28 patients with transverse flat foot and a control group constituted of 21 patients with normal foot arch in the Daily Rehabilitation Center in Ostrowiec. The average age of the patients was 52 ± 11.5. In order to check the influence of transverse flat feet to maintain balance, patients were assessed according to Berg Balance Scale. The test assesses the performance of Berg's fourteen activities of daily living, namely: change of position from sitting to standing, standing without help, sitting without support, changing position from standing to sitting, transfer, standing with closed eyes, standing with feet together, picking objects from the floor, standing on one leg, twisting of torso at still feet, reaching forward while standing, rotating 360 degrees, standing on a step, standing in one line (one foot behind the other). Both groups were subject to the same program of balance study. Individual tasks are organized in the order of execution from the easiest to the most difficult and evaluated on the five-point scale (0-4). If a person does not meet time requirements, is supported or needs supervision on the part of the examiner, receives a smaller number of points. Person should understand that he must maintain

a balance in carrying out his attempts. The choice on which leg to stand on, or how far to reach, they are at the patient discretion. The maximum result possible to obtain in the test is 56 points. The equipment required for testing include: stopwatch, measuring tape or another distance indicator. Chairs, in the course of testing, should be of reasonable height. The step or platform should be the height of the average step. Interpretation of test concerning persons reaching the norm was above 41 points in the high jump, and those below this value reached a lack of norm which is associated with an increased risk of falling.

Results

Figure 1 presents data showing maintaining a balance in adults with a transverse flat foot. In the 28 person group with transverse flat foot, 19 persons (68%), achieved results ranging from 21-40 points, and only 9 persons (32%) were in the range of 41-56 standard points. Figure 2 presents data showing maintaining a balance in people with a normal arch feet. Whereas in group of 21 persons with a normal arch feet, 15 patients (71%), reached the norm and they fit into the range of 41-56 points, only six patients (29%) did not reach the norm. Table 1 presents the results analyzed statistically. Statistical analysis by T-test for independent samples showed that the positive values and smaller imbalance occur more often in the examined with the proper arched foot and are therefore less prone to falls, negative values and associated with them imbalance consequently leading to falls occur twice as often in subjects with transverse flat foot. Group differences were statistically significant.

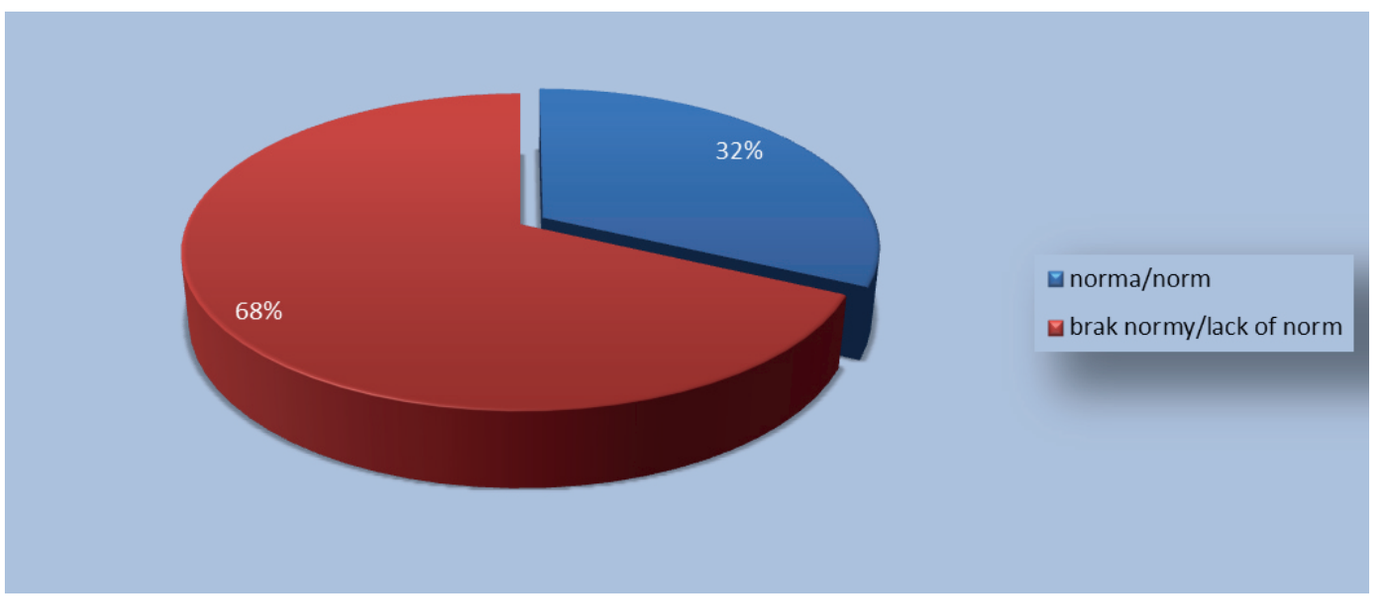

Figure 1. The result obtained in the Berg balance test in patients with transverse flat foot

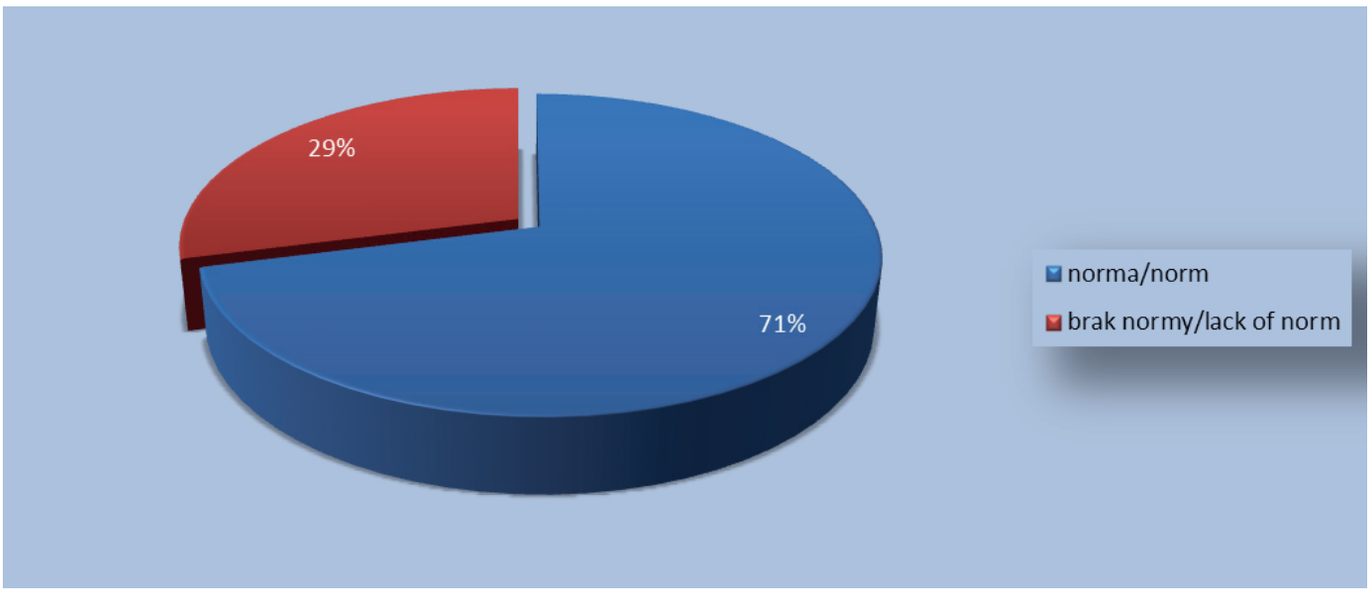

Figure 2. Result obtained in the Berg balance test in patients with normal transverse arch of the foot

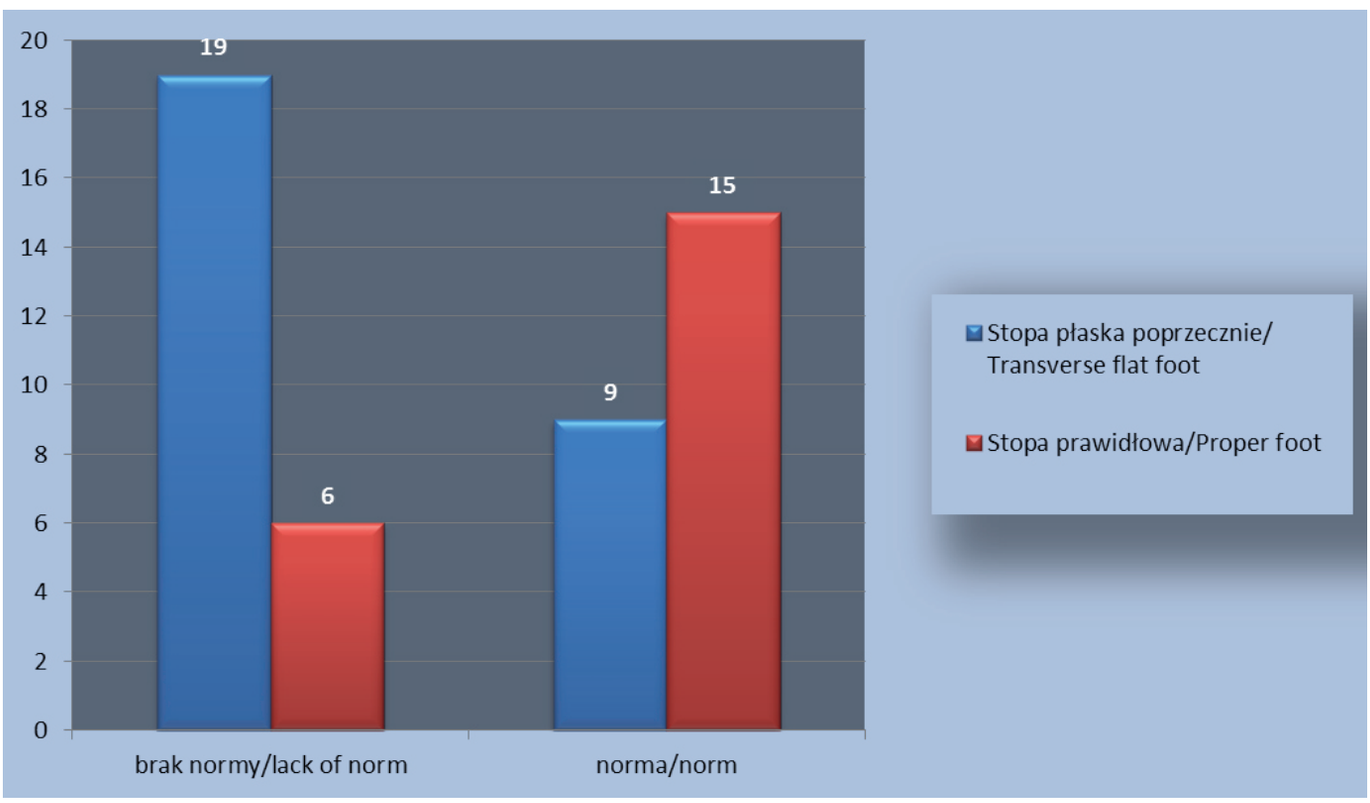

Figure 3. The results obtained in the two study groups

fizjoterapia polska
nr 3/2015 (15)

Table 1. The results of the two groups of examined persons subject to statistical analysis

		Statistics for groups				Levene's homogenity test of variance		T-test equality of means		
	Group	n	mean	SD	The standard error of mean	F	Significance	t	df	p
result	Transverse flat foot	28	0.3571	0.95119	0.17976	0.284	0.597	2,894	47	0.006
	Property arched foot	21	0.4286	0.92582	0.20203					

Discussion

The main symptom of postural instability are imbalances that result in falls. The problem of loss of balance occurs in almost 14% of the population aged 50-60 [12]. Persons with a transverse flat foot are more vulnerable to loss of balance and the associated with this risk of falling. Proper distribution of the center of gravity on the foot helps to maintain balance while walking, when the body is constantly off balance. Those persons having a transverse flat feet are not able to take the burden on the support points but rather distribute the pressure on the whole foot. It often happens that the result of the flattening of dynamic arc incurred at the place the greatest burden. Overloading related to improper distribution of static forces further disturbs the balance and increases the risk of falls in the elderly. Berg's test results show how platypodia affects maintaining balance during position changes, when support points, receiving load, must work intensively. The functional Berg's Balance Scale includes similar tests to those used in the Tinnetti's test, widened to assess the functional range (Duncan test), lifting small objects from the floor, turning of heads, standing on the step, standing on one leg. Berg's scale has even higher degree of compliance (98% compliance of test results obtained by different evaluators). In a study of Ostrowska et al. [19], sensitivity in the ability to predict the risk of falls in the group of persons reporting falls amounted to 54% and the specificity of prediction of lack of falls in patients without incidents, amounted to 62%. This prognosis concerned persons who received 40 or less points on the Berg's scale. The increase of the threshold by the authors to 45 or less resulted in a significant increase in sensitivity (82%) and a small decrease in specificity (52%). Different results for the same score received Riddle and Stratford [20] getting 64-percent sensitivity and 90-percent specificity, while Trader et al. [21] respectively 60 percent and 40 percent. Most study results suggest the conclusion that there is the risk of falls in case of obtaining 45 points or less [22]. This study confirms that the transverse flat foot has a significant effect on the maintenance of balance and therefore an increased risk of falling.

Conclusions

1. In patients with transverse flat foot there were significantly worse results in maintaining the balance than in people with normally arched feet.
2. Persons with transverse flat foot are more vulnerable to falls with age.

Adres do korespondencji / Corresponding author

Mgr Sylwia Czesna

Ośrodek Rehabilitacji Dziennej, NZOZ Opiekun
ul. Słowackiego 58, 27-400 Ostrowiec Świętokrzyski
e-mail: sylwia972@tlen.pl, Tel: 604-139-403

Piśmiennictwo/ References

1. Ewa Puszczałowska-Lizis., Frequency of transverse flat feet occurrence instudents in the light of two techniques of plantography preparations, Kwart. Ortop. 2011, 3, str. 267
2. Riva D, Trevisson P, Minoletti R, Venturin N, Ricco MC. Il controllo postural static e dinamico in appoggio monopodalico. Il Fisioterapista 2001, 2:3-4.
3. Karabay N, Toros T, Hurel C. Ultrasonographic evaluation in plantar fasciitis. J Foot Ankle Surgery 2007, 46(6):442-446.
4. Starosta W.: Motoryczne zdolności koordynacyjne. Międzynarodowe Motoryki Sportowej, Warszawa 2003.
5. Bąk S., Postawa ciała, jej wady i leczenie, PZWL Warszawa 1965.
6. Bohannon R.W., Leary,: Standing balance and function over the course of acute rehabilitation. Arch. Phys. Med. Rehabil. 1995,76,994-996
7. Starosta W.: Globalna i lokalna koordynacja ruchowa. Miedzynarodowe Stowarzyszenie Motoryki Sportowej. Warszawa 2006.
8. Golema M. (2002): Charakterystyka procesu utrzymywania równowagi ciała człowieka w obrazie stabilograficznym. Studia i Monografie AWF Wrocław.
9. Funk D.A., Cass J.R., Johnson K.A.: Acquired adult flat foot secondary to posterior tibial-tendon pathology. J. Bone Joint Surg. 1986, 66A, 95.
10. Holmes G.D., Mann R.A.: Possible epidemiological factors associated with rupture of the posterior tibial tendon. Foot Ankle 1992, 13, 70.
11. Huang C.K., Kitaoka H.B., An K.N., Chao E.Y.: Biomechanical evaluation of longitudinal arch stability. Foot Ankle. 1993, 14, 353.
12. Deland J.T., Arnoczky S., Thompson F.: Adult acquired flatfoot deformity at the talonavicular join: reconstruction of the spring ligament in an in vitro model. Foot Ankle 1992, 13, 322.
13. Baxter D.E., Thigpen C.M.: Heel pain – operative results. Foot Ankle 1984, 5, 16.
14. Leach R.E., Seavey M.S., Salter D.K.: Results of surgery in athletes with plantar fascitis. Foot Ankle 1986, 7, 156.
15. Błaszczyk J. i wsp. (1993): Evaluation of the postural stability in man: movement and posture interaction. Acta Neurobiol. Exp.; 53: 155-166.
16. Kuczyński M. (2003): Model lepko – sprężysty w badaniach stabilności postawy człowieka, Studia i Monografie, AWF Wrocław, ss.110.
17. Golema M. (2003): Wielkość przemieszczeń części ciała człowieka utrzymującego równowagę, Studia i Monografie z. 148, Politechnika Opolska, Opole, ss. 147.
18. Błaszczyk J. (1993): Kontrola stabilności postawy ciała. Kosmos, 42, 2, 473-486.
19. Ostrowska B., Sadowska Z., Skolomowski J.:Ocena zaburzeń stabilności postawy u osób w starszym wieku leczonych uzdrowiskowo. Ortopedia- Traumatologia- Rehabilitacja 2006;4:441-448.
20. Riddle D.,Stratford P.:Interpreting validity indexes for diagnostics tests: a illustration using the Berg Balance Test. Phys. Ther. 1999;79:939-948.
21. Trader S., Newton R., Cromwell R.: Balance abilities of Homebound older adults classified as fallers and nonfallers. J. Geriatr. Phys. Ther. 2003; 26:3-8.
22. Lajoie Y., Gallagher S.P.: Predicting Falls within the elderly community: comprarison of postural sway, re action time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch. Gerontol. Geriatr.2004; 38:11-26.