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Dymorfizm płciowy cech morfologicznych stóp kobiet i mężczyzn po 60 roku życia

Sexual dimorphism in foot morphology in women and men over 60

Ewa Puszczałowska-Lizis[1(A,B,C,D,E,F)], Przemysław Bujas[2(A,B,C)], Jarosław Omorczyk[2(A,B,D)], Leszek Nosiadek[3(D,F)]

[1]Uniwersytet Rzeszowski, Wydział Medyczny, Instytut Fizjoterapii, Rzeszów, Polska/
University of Rzeszow, Faculty of Medicine, Institute of Physiotherapy, Rzeszow, Poland
[2]AWF Kraków, Wydział Wychowania Fizycznego i Sportu, Instytut Sportu, Kraków, Polska/
University of Physical Education in Cracow, Faculty of Physical Education and Sport, Institute of Sport, Cracow, Poland
[3]AWF Kraków, Wydział Wychowania Fizycznego i Sportu, Instytut Nauk Biomedycznych, Kraków, Polska/
University of Physical Education in Cracow, Faculty of Physical Education and Sport, Institute of Biomedical Sciences, Cracow, Poland

Streszczenie

Wstęp. Stopa ludzka, będąca elementem podporowo-nośnym, kształtuje się przez całe życie, w indywidualny dla każdego człowieka sposób. W wieku podeszłym jest szczególnie narażona zmiany inwolucyjne. Celem pracy jest określenie różnic dymorficznych w wybranych cechach budowy stóp między kobietami a mężczyznami po 60 roku życia.

Materiał i metody. Badaniami metodą podoskopową objęto seniorów z województwa podkarpackiego i małopolskiego, w tym 116 kobiet i 82 mężczyzn. Badanych kwalifikowano do 3 przedziałów wieku: 60-69 lat, 70-79 lat, 80-90 lat. W analizach uwzględniono następujące wskaźniki: kąt Clarke'a, kąt piętowy (γ), kąt koślawości palucha (α), kąt szpotawości V palca (β). Obliczono podstawowe miary statystyki opisowej. Istotność różnic cech morfologicznych stóp między kobietami a mężczyznami oceniono testem U Manna-Whitney'a.

Wyniki. U obu płci stwierdzono pogorszenie się analizowanych wskaźników w stosunku do wartości normatywnych. Statystycznie istotne międzypłciowe różnice dotyczyły wartości kąta Clarke'a i kąta koślawości palucha (α).

Wnioski. Cechami znamiennie różnicującymi stopy kobiet i mężczyzn po 60 roku życia są: kąt Clarke'a i kąt koślawości palucha (α). Upowszechnianie kinezyprofilaktyki gerontologicznej powinno stanowić nieodzowny element w działaniach ukierunkowanych na opóźnianie procesów inwolucyjnych, w celu utrzymania na optymalnym – w stosunku do wieku – poziomie sprawności statyczno-dynamicznej narządu ruchu.

Słowa kluczowe:
starzenie się, stopa, wysklepienie podłużne, wysklepienie poprzeczne, ustawienie palucha, ustawienie V palca

Abstract

Background. The human foot is a supportive and locomotive element, which forms during a whole life in individual manner for every person. In advanced age, the foot is particularly exposed to involutionary changes. The aim of this study was to determine the dimorphic differences in the selected morphological features of the feet in women and men aged over 60.

Material and methods. The research conducted by podoscopic method involved seniors from the Podkarpackie and the Małopolskie voivodeships, including 116 females and 82 males. Tested persons were divided into three age groups (60-69 years, 70-79 years, 80-90 years). The following indices were analyzed: the Clarke's angle, heel angle (γ), hallux valgus angle (α), and the V toe varus deformity angle (β). Basic descriptive statistics were calculated. The Mann-Whitney U test was used to assess significance of the differences in morphological features of the feet between the women and men.

Results. In both sexes the analysed indices worsened in comparison to the normative values. Statistically significant differences between woman and man concern the Clarke's angle and the hallux valgus angle (α).

Conclusions. The most important plantographic features which differentiate the feet structure of women and men aged over 60 are Clark's angle and the hallux valgus angle (α). The popularisation of preventative kinesiotherapy for the elderly should constitute an indispensable element of action aimed at slowing down involution processes to maintain the optimal – according to age – static and dynamic conditions of the locomotion system.

Key words:
ageing, foot, longitudinal arch, transverse arch, arrangement of the hallux, arrangement of the fifth toe

Introduction

Aging of human body is a natural process progressing at different pace, followed by a gradual decline in the functional reserves of all organs. This process involves the biological dimension of metabolism which slows down, reduction in the cell renewal capacity, buildup of calcium deposits and cholesterol in tissues [1]. Diseases of the cardiovascular, respiratory and nervous systems are very common. They are

followed by disorder or decrease in the functioning of visual, auditory, tactile, movement and others analyzers. Elderly man gets tired quickly due to the fact that the perception of objects and phenomena requires more effort. This leads to progressive muscle atrophy, decrease in muscle strength and a loss of bone mass. Between the age of 60 and 85 muscle strength decreases by about 20-40% compared to values obtained at the age of 25. The age band 50 to 70 yrs. is followed by a decline on average by 15% per decade [2]. After the age of 50 a gradual decrease in the number of muscle fibers and muscle cross-section are observed. At the age of 80 the decline is about 40% compared to the balance achieved at the age 20 [3]. It is worth noting that the old age is associated with a high incidence of lesions causing pain, immobility, and the need for medication. Periods of inactivity affect the deterioration of the condition, further weakening of the strength, flexibility and endurance, and functional loss of postural stability, contributing to the increased risk of falls and injuries to the musculoskeletal system. Changes in the musculoskeletal system lead to a loss of elasticity of cartilage, as well as a decrease in the flexibility of the fascia and joint capsules. Osteoarthritis are a source of pain and lead to a gradual reduction in mobility. Old age, the history of bone and joint diseases and comorbidities correlated positively with depressive symptoms [4].

Focusing on the issues concerning feet, it is worth noting that this is a carrying-supporting element, absorber of shock generated during locomotion movements. It is a part of the musculoskeletal system shaped on an individual basis for each person, depending on the life style, the nature of the work, the type of shoes worn, as well as illnesses. The acceleration of involution changes in the foot influences insufficient amount of activity caused by the lack of interest in physical activity, the presence of pain, loss of stamina and physiological efficiency of the body and often isolation from the outside world caused by depression. Based on the foregoing, it can be said that the architecture of the foot is a picture of the skeletal, musculo-ligamentous system and possibly ongoing disease processes in other systems or organs.

The aim of the study was to characterize a geriatric foot and determine dimorphic differences in selected characteristics of the foot construction between women and men over 60 yrs.

Material and methods

The examinations in January 2016 involved 198 seniors from the Podkarpackie and the Małopolskie voivodeships, including 116 females and 82 males. The inclusion criteria to research were: age in the range 60-90 years, dominating right hand and right leg determined on the basis of Waterloo Handedness and Footedness Quertionaire – Revised [5], physical fitness that allowed for walking without orthopaedic equipment and ability to take independently a standing position on the podoscop, a written consent to participate in the study.

Three age bands were distinguished. 38 women (average age: 64.53±3.11 years) and 31 men (average age: 65.29±3.15 years) were enrolled in the band 60-69. The band 70-79 consisted of 35 women (average age: 75.13±3.45 years) and 28 men (average age: 73.89±2.70 years), while the band 80-90

years included 43 women (average age: 85.47±3.38 years) and 23 men (average age: 84.96±3.97 years).
The research tool was podoscop CQ-ST Elektronik System. The calculations included following indices: the Clarke's angle, heel angle (γ), hallux valgus angle (α), and the V toe varus deformity angle (β). Anthropometric measurements of the body mass and height were taken. The obtained data was used to calculate BMI index. Basic descriptive statistics of the somatic features in the examined seniors presents table 1.

Table 1. Descriptive statistics of somatic features of tested persons

Age	Females			Males			Z	p
	$\bar{x}$±s	Me	max-min	$\bar{x}$±s	Me	max-min		
Body weight								
60-69	73.81±15.48	75.00	105.80-40.00	81.47±11.39	80.00	108.00-63.30	-1.92	0.054
70-79	70.72±16.29	70.00	115.00-45.00	79.41±12.54	79.00	110.90-58.00	-2.32	0.020*
80-90	61.85±12.69	59.50	96.10-38.00	77.56±13.49	78.00	114.50-57.40	-3.98	0.000*
Body height								
60-69	160.37±7.51	162.00	172.00-135.00	171.13±6.02	171.00	185.00-162.00	-5.29	0.000*
70-79	157.00±8.64	158.00	171.00-135.00	168.68±6.88	169.50	181.00-153.00	-4.94	0.000*
80-90	153.67±8.01	153.00	177.00-138.00	168.17±4.41	167.00	178.00-161.00	-5.98	0.000*
BMI index								
60-69	28.52±5.58	27.96	42.46-17.30	27.73±3.58	27.31	37.37-20.48	0.62	0.534
70-79	28.65±5.55	28.33	40.30-18.97	27.90±3.76	27.62	35.40-20.20	0.47	0.638
80-90	26.68±6.80	24.05	47.66-17.99	27.33±4.03	27.00	36.14-20.24	-1.20	0.231

*p<0.05

The study was granted permission by the Ethical Review Board of the Rzeszow University. In order to preserve the integrity of the research process, all the measurements were carried out in the gym, in the morning, using the same measuring instruments operated by the authors. Seniors were wearing gymnastic costumes without shoes, after receiving detailed information concerning the aim and methodology used in the study.
On the basis of the gathered data the following descriptive statistics were calculated: arithmetical mean values ($\bar{x}$), standard deviaitons (s), medians, (Me). The normalcy of distribution of particular characteristics was verified by means of the Shapiro-Wilk test. In order to evaluate intersexes differences in average level of tested variables we used the non-parametric Mann-Whitney U test. Differences were considered statistically significant if the probability level of the test was lower than the predetermined level α=0.05. In this paper the STATISTICA StatSoft 10.0 was used to process the statistical test results.

Results

Table 2 provides descriptive statistics of selected parameters of the construction of women's and men's feet. These data point to lowering of the longitudinal arch in the analyzed periods of ontogenesis in relation to the norms of the adult population, which, according to Lizis [6] amounted to 40-51°. Considering the level of the longitudinal arch it should be noted that in both sexes average value of the Clarke's angle were lower on the left foot. Based on intersexes comparisons statistically significantly lower values of the Clarke's

Table 2. Comparision of morphological features of feet structure in distinct females and males groups

Age	Females			Males			Z	p
	$\bar{x}\pm s$	Me	max-min	$\bar{x}\pm s$	Me	max-min		
Clark's angle of the right foot								
60-69	31.92±9.63	33.50	48.00-10.00	36.64±7.09	39.00	47.00-17.00	-2.11	0.035*
70-79	27.43±11.43	27.00	49.00-10.00	35.21±8.02	39.00	46.00-15.00	-2.83	0.005*
80-90	26.42±9.36	29.00	40.00-5.00	35.48±7.67	38.00	48.00-19.00	-3.74	0.000*
Clark's angle of the left foot								
60-69	31.26±9.56	30.50	48.00-11.00	35.93±7.09	38.00	49.00-16.00	-1.98	0.047*
70-79	26.86±10.06	26.00	42.00-7.00	34.89±7.24	39.00	42.00-18.00	-3.21	0.001*
80-90	24.91±8.60	26.00	40.00-8.00	33.96±6.77	35.00	45.00-18.00	-3.81	0.000*
Heel angle (γ) of the right foot								
60-69	17.03±3.05	17.00	23.00-10.00	15.93±2.13	17.00	20.00-11.00	1.42	0.156
70-79	16.83±2.08	17.00	20.00-12.00	16.64±2.86	17.00	23.00-11.00	0.22	0.825
80-90	15.51±2.27	15.00	20.00-10.00	15.74±2.14	15.00	20.00-13.00	0.15	0.882
Heel angle (γ) of the left foot								
60-69	16.66±2.53	16.50	22.00-12.00	16.26±1.97	16.00	20.00-12.00	0.70	0.484
70-79	17.28±1.99	17.00	20.00-10.00	16.53±2.33	17.00	22.00-12.00	1.46	0.144
80-90	15.63±2.13	15.00	20.00-11.00	15.83±2.57	15.00	21.00-12.00	-0.17	0.861
Hallux valgus angle (α) of the right foot								
60-69	11.08±7.18	10.50	29.00-0.00	11.22±7.67	10.00	35.00-0.00	0.14	0.890
70-79	16.26±10.28	14.00	44.00-0.00	10.11±4.84	10.00	21.00-0.00	2.45	0.014*
80-90	15.49±9.12	14.00	40.00-0.00	9.30±7.50	8.00	33.00-0.00	2.88	0.004*
Hallux valgus angle (α) of the left foot								
60-69	11.26±6.30	10.00	30.00-0.00	11.84±8.23	12.00	34.00-0.00	-0.37	0.708
70-79	19.46±10.97	20.00	45.00-0.00	11.03±6.82	9.00	27.00-0.00	3.33	0.001*
80-90	16.21±9.63	17.00	45.00-0.00	9.52±8.29	8.00	32.00-0.00	2.74	0.006*
The V toe varus deformity angle (β) of the right foot								
60-69	16.63±5.82	18.00	27.00-0.00	15.90±4.32	15.00	25.00-7.00	0.71	0.477
70-79	17.66±5.25	17.00	27.00-7.00	17.71±5.69	16.00	28.00-8.00	0.04	0.967
80-90	18.44±6.74	19.00	32.00-6.00	19.30±6.33	19.00	28.00-3.00	-0.60	0.545
The V toe varus deformity angle (β) of the left foot								
60-69	15.13±6.50	16.00	28.00-0.00	16.13±6.32	17.00	24.00-0.00	-0.98	0.328
70-79	15.94±5.72	15.00	28.00-0.00	16.21±6.34	15.00	27.00-0.00	-0.10	0.923
80-90	17.79±5.68	18.00	35.00-9.00	18.17±5.65	18.00	27.00-5.00	-0.38	0.701

*$p<0.05$

angle were found in women, regardless of the age category. Average values of the heel angle (γ) do not deviate from the norms and were similar for the right and left foot. There were no statistically significant differences between sexes regarding this indicator. On this basis it can be concluded that involution changes equally affect the size of the heel angle for women and men. Average values of the hallux valgus angle (α) in both women and men ranged above the upper limit of the norm adopted at the variation area from 0º to 9º [7]. In case of women in the age band of 70-79 yrs. and 80-90 yrs., higher values were recorded in the left foot than the right one. A intersexes comparison showed

a statistically significantly higher rates of indicators in question in the women. These differences were found in the case of persons qualified for the age groups 70-79 yrs. and 80-90 yrs. The average V toe varus deformity angles (β) were similar in the right and left foot. They were in the range of 15º to 19º indicating a significant increase compared to norms. There was a growing trend starting from the age band 60-69 yrs. to 80-90 inclusive. Similarly to the heel angle, no statistically significant intersexes differences between the analyzed indicator were found, which indicates that they are the most important characteristics of the geriatric foot differentiating women and men.

Discussion

Insufficient number of reports concerning intersexes comparisons of feet construction can be found in the literature. Demczuk-Włodarczyk [7] on the basis of the studies of children and adolescents aged 3-20, stated that dimorphism of longitudinal feet architecture is clear from the early age and affects both the amount of arches, the pace of their development and symmetry of shape. Comparing the longitudinal arch, she found that the girls' feet are better shaped up to 15 yrs., while after the age of 15 the height of the longitudinal arch is greater in boys. The research by Puszczałowska-Lizis and Kwolek [8] showed that between men and women aged 20-28 yrs., there are differences between sexes in longitudinal feet arch and setting of the V toe. Women have better longitudinal arch in feet than men. Men have a tendency to more varus setting of the V toe, which may result from the increased load on the lateral edge of the foot. Sexual dimorphism is not visible in the transverse arch and hallux valgus angle, allowing to claim that they are the most important features differentiating feet formation in men and women in the period of ontogenesis. With age, due to involution changes occurs static and dynamic foot failure, causing distortion and pain. Scientific reports indicate that the dynamics and nature of these changes may be related to gender. Gorter et al. [9] on the basis of the research of 7,200 inhabitants of the Netherlands aged above 65, recognized the female sex as a risk factor for non-traumatic foot problems lasting more than 4 weeks. Paiva de Castro et al. [10] studied feet of people over 65 yrs. and found more significant hallux valgus in women in the absence of statistically significant differences between sexes in the longitudinal arch. While Aurichio et al. [11] on the basis of comparative studies of seniors' feet found greater flattening of dynamic arch in women. The authors demonstrated the relationship between the increase in BMI and flat feet. Mickle et al. [12] on the basis of 312 people over the age of 60 observed more significant valgus setting of the hallux and the heel in women and greater V toe varus deformity angle in men.

In our study, deterioration of analyzed indicators in comparison to normative values was found in both sexes. Features significantly differentiating feet in men and women over 60 are: the Clarke's angle and the hallux valgus angle (α). Female sex is characterized by worse longitudinally arched feet and more significant hallux valgus. This trend certainly results from intensified with age degeneration of active-passive stabilizers, which increasingly threatens the delicate construction of women's feet. Disturbed anatomical relationships, including feet arch structure largely influences the weakening of the ligaments of the plantar calcaneonavicular ligament and lowered tone of connective tissue plaque stretched between the calcaneus ligament and the

tibionavicular part of quadrate ligament. The effect of growing static and dynamic foot failure resulting from involution changes is directing a substantial portion of the burden on the forefoot, causing hallux valgus. The pain accompanying this deformation is the reason for the search for the optimal settings and mechanisms relieving anterior-medial edge of the foot, which results in distortion of the other toes. Consequences of changes in the static system of feet in the researched women can be seen in the significant increase in the V toe varus deformity angle - in relation to the norms. It is certainly due to more burden on the lateral edges of the foot in order to mitigate the effects of cumulative pressure forces within their anterior-medial surface. The reported increase in the V toe varus deformity angle in the women in question blurs intersexes differences in the values of this indicator.

There are reports in the literature of authors studying the effects of various factors on foot deformities. Janchai et al. [13] who analyzed the results of 213 Bangkok residents aged 60-80 yrs. found distortions in 87% of the respondents, 45% of deformations accounted for hallux valgus observed in both sexes, although in case of women it showed greater severity in Manchester scale. The relationship between hallux valgus and flat feet was found, which was more often observed in women than in men. Golightly et al. [14] conducted a study on the impact of gender, race, age, body built on the incidence of hallux valgus in 1,502 people aged on average 68. Studies showed that this deformation affected women more often and was related to ethnicity. Representatives of African-Americans more often had hallux valgus compared to Caucasians. The presence of hallux valgus was associated with age, and coincided with flat feet. In turn, Perera et al. [15] concluded that women compared to men are more predisposed to hallux valgus, both because of wearing narrow, high-heeled shoes, as well as due to the delicate construction of the feet, especially the head of the first metatarsal bone, which is smaller and more rounded, reducing the stability of the MTP joint. Wyderka et al. [16] reported that the cause of foot deformity in women is less resistance of active-passive foot stabilizers and wearing too high heeled shoes. Menz and Morris [17] characterized footwear and foot problems in people aged 62-96. Based on a comparison of length, width and surface of the shoe with feet dimensions, they found that women compared to men wore more ill-fitting footwear that was too narrow and short. The authors pointed to the universality of the inappropriate choice of footwear among the elderly, which is the cause of distortion and pain in the feet. Vanore et al. [18] highlighted the difficulty in finding comfortable shoes for people with hallux valgus. Widening of the forefoot and protrusion towards the medial part of the head of the first metatarsal bone as a result of its varus is the cause of irritation with footwear, which can cause painful bursitis surrounding metatarsophalangeal joint of the I toe on the medial side or neuritis of the dorsal medial cutaneous nerve.

Our study may be a clue to the actions directed to the use of optimal preventive solutions to the feet endurance deteriorating with age. An important element of optimal - in relation to age - functioning are properly selected shoes, taking into account changes aggravating with age in the foot construction. This is particularly important for women who have an inherently delicate build and weaker muscular and ligament apparatus. The prophylaxis footwear should lift the medial edge of the foot, prevent deformation, callous and pain in the forefoot. It is

important to use hallux valgus separators, and appropriately selected inserts relieving places where pressure forces cumulate. Passive correction of foot setting reduces pain, improves gait pattern and reduces the risk of falls. Supplementary exercises are aimed at raising the efficiency of the relevant muscles, increasing flexibility of periarticular structures, improving joint mobility and feet proprioception. Prevention of foot deformities should be conducted in a comprehensive manner, which means that it should apply to both protection of feet against distortion and diseases, as well as care for the proper functioning of the whole organism. Popularization of gerontologic kinesis prophylaxis should be an indispensable element in actions aimed at delaying the involution processes, in order to maintain optimal - in relation to age - level of efficiency of static and dynamic organ movement.

Conclusions

The most important plantographic features which differentiate the feet structure of women and men aged over 60 are Clark's angle and the hallux valgus angle (α). Female sex has a worse longitudinally arched feet and more pronounced hallux valgus. Special attention in prevention and mitigation of foot deformity should be paid to the selection of footwear, which should lift the medial edge of the foot and prevent compensation distortion, callous and pain in the forefoot.

Adres do korespondencji / Corresponding author

Dr Ewa Puszczałowska-Lizis

Uniwersytet Rzeszowski, Instytut Fizjoterapii
35-205 Rzeszów, ul. Warszawska 26 A
tel. 17 872-19-20
e-mail: ewalizis@poczta.onet.pl

Piśmiennictwo/ References

1. Grodzicki T, Kocemba J, Skalska A, red. Geriatria z elementami gerontologii ogólnej. Via Medica Gdańsk; 2007.
2. Booth FW, Weeden SH, Tseng BS. Effect of aging on human skeletal muscle and motor function. Med Sci Sports Exerc 1994; 26 (5): 556-560.
3. Doherty TJ. Invited review: Aging and sarcopenia. J Appl Physiol 2003; 95 (4): 1717-27.
4. Kaczmarek M, Moneta P, Żytkowski A i wsp. Objawy depresji u starszych pacjentów z chorobami układu ruchu poddanych rehabilitacji szpitalnej. Ortop Traumatol Rehabil 2014; 16 (6): 645-60.
5. Perrin P, Deviterne D, Hegel F, et al. Judo, better than dance, develops sensorimotor adaptabilities involved in balance control. Gait Posture 2002; 15 (2): 187-94.
6. Lizis P. Kształtowanie się wysklepienia łuku podłużnego stopy i problemy korekcji płaskostopia u dzieci i młodzieży w wieku rozwojowym. Podręczniki i Skrypty nr 10. AWF Kraków; 2000.
7. Demczuk-Włodarczyk E. Budowa stopy w okresie rozwoju progresywnego człowieka. Studia i Monografie nr 66. AWF Wrocław; 2003.
8. Puszczałowska-Lizis E, Kwolek A. Dymorfizm płciowy w wybranych cechach budowy stóp kobiet i mężczyzn w wieku 20-28 lat. [W:] Efekty kształcenia i wychowania w kulturze fizycznej. Red. J. Ślężyński. AWF Katowice; 2011.
9. Gorter KJ, Kuyvenhoven MM, de Melker RA. Nontraumatic foot complaints in older people. A population-based survey of risk factors, mobility, and well-being. J Am Podiatr Med Assoc 2000; 90 (8): 397-402.
10. Paiva de Castro A, Rebelatto JR, Aurichio TR. The effect of gender on foot anthropometrics in older people. J Sport Rehabil 2011; 20 (3): 277-86.
11. Aurichio TR, Rebelatto JR, de Castro AP. The relationship between the body mass index (BMI) and foot posture in elderly people. Arch Gerontol Geriatr 2011; 52 (2): 89-92.
12. Mickle KJ, Munro BJ, Lord SR et al. Foot shape of older people: implications for shoe design. Footwear Science 2010; 2 (3): 131-9.
13. Janchai S, Chaiwanichsiri D, Silpipat N et al. Ageing feet and plantar arch characteristics of the Thai elderly. Asian Biomed 2008; 2 (4): 297-303.
14. Golightly YM, Hannan MT, Dufour AB et al. Factors associated with hallux valgus in a community-based cross-sectional study of adults with and without osteoarthritis. Arthritis Care Res 2015 ; 67 (6): 791-8.
15. Perera AM, Mason L, Stephens MM. The pathogenesis of hallux valgus. J Bone Joint Surg Am 2011; 93 (17): 1650-61.
16. Wyderka M, Wyderka I, Gronowska T i wsp. Paluch koślawy a jakość życia. Pielegniarstwo Polskie 2013; 3 (49): 169-75.
17. Menz HB, Morris ME. Footwear characteristics and foot problems in older people. Gerontology 2005; 51(5): 346-51.
18. Vanore JV, Christensen JC, Kravitz SR et al. Diagnosis and Treatment of First Metatarsophalangeal Joint Disorders. Section 1: Hallux Valgus. J Foot Ankle Surg 2003; 42 (3): 112-23.