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Effect of structural foot deformities on foot function in the elderly

Yasemin Kavlak, Engin Şimşek, Suat Erel, Akmer Mutlu, Nilgün Bek, Yavuz Yakut, Fatma Uygur

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Research Report

Y Kavlak
Eskişehir Osmangazi University, Health Services Vocational School, Eskişehir, Turkey,
PT, PhD

E Şimşek, S Erel, A Mutlu
Hacettepe University, School of Physical Therapy and Rehabilitation, Ankara, Turkey,
PT, MSc

N Bek
Hacettepe University, School of Physical Therapy and Rehabilitation, Ankara, Turkey,
PT, PhD, Assoc Prof

Y Yakut, F Uygur
Hacettepe University, School of Physical Therapy and Rehabilitation, Ankara, Turkey,
PT, PhD, Prof

Address correspondence to:
Dr. Fzt. Yasemin Kavlak
Eskişehir Osmangazi University, Health Services Vocational School, Meşelik Campus 26480
Eskişehir, Turkey
E-mail: ykavlak@hotmail.com

Purpose: This study was undertaken to determine how structural foot problems affected foot function and walking speed in the elderly. **Materials and methods:** Thirty nine elderly retirement home residents without significant disease and an average age of 74.36±7.71 (55-91) years were assessed for presence of deformity, the severity-rigidity and symptoms of that deformity, and the number of deformities. Subjects were also evaluated for total muscle strength of related muscles, Foot Function Index (FFI) and comfortable walking speed of 100 meters. Correlations between these parameters were investigated. **Results:** The results showed that there was a statistically significant correlation only between walking speed, total muscle strength and foot function index ($r=0.353$-0.499, $p<0.05$). No relation was found between total deformity score and the other evaluated parameters ($p>0.05$). **Conclusion:** To provide an insight for the complex nature of elderly foot problems factors like foot pain, nail problems and hyperkeratotic lesions should also be taken into consideration besides structural foot deformities.

Key words: Geriatrics, Foot, Foot deformities.

Yaşlılarda yapısal ayak deformitelerinin ayak fonksiyonları üzerine etkisi

Amaç: Bu çalışma, yapısal ayak problemlerinin geriatriklerde ayak fonksiyonu ve yürüme hızını nasıl etkilediğini belirlemek üzere gerçekleştirildi. **Gereç ve Yöntem:** Belli bir hastalığı olmayan, ve yaş ortalaması 74.36±7.71 (55-91) yıl olan huzurevinde yaşayan 39 yaşlı üzerinde deformite varlığı, deformitenin şiddeti-rijiditesi, semptomları ve deformite sayısı değerlendirildi. Ayrıca olguların ilgili kaslarda kas kuvveti, Ayak Fonksiyon İndeksi (FFI) ve 100 metre yürüyüş hızları değerlendirildi. Bu parametreler arasındaki korelasyon incelendi. **Sonuçlar:** Sadece yürüme hızı ile toplam kas kuvveti ve ayak fonksiyon indeksi arasında istatistiksel olarak anlamlı korelasyon bulundu (r: 0.353-0.499, $p<0.05$). Total deformite skoru ve diğer değerlendirilen parametreler arasında ilişki bulunmadı ($p>0.05$). **Tartışma:** Geratriklerde ayak problemlerinin karmaşık doğasını kavrayabilmek için yapısal ayak deformitelerinin yanı sıra ağrı, tırnak problemleri ve hiperkeratotik lezyonlar gibi faktörler de göz önünde bulundurulmalıdır.

Anahtar kelimeler: Geriatri, Ayak, Ayak deformiteleri.

Changes in foot structure with aging can affect mobility and quality of life, foot pain can also hinder quality of life by diminishing well-being and self esteem and the ability to work, play and interact socially.[1] Epidemiological studies have shown that up to 80% of people older than 65 years have at least one foot problem which requires podiatric treatment and that foot pain impairs balance and functional ability in community-dwelling older people.[2,3] It has also been reported that geriatric people consider foot problems to be important only if these problems significantly affect their ability to carry out basic activities of daily living. Early detection and appropriate referral for the management of foot disorders is the key to maintaining mobility and functional independence.[4] In spite of their importance, foot problems have often been simply recorded as a simple dichotomous variable. A composite scoring method would overcome this shortcoming and render results compatible with statistical analysis.

In 1995 Reuben et al reported that the information obtained with performance based and self-report measures of physical function were complementary.[5] Taking this idea into consideration we reasoned that by selecting a performance based measure of physical function like gait speed, muscle strength and correlating it with a self-report measure (for example Foot Function Index, FFI) could maximize the description of physical function in older adults as advocated by Swearingen and Brach.[6]

In this study we tried to determine the impact of structural foot deformities on walking speed, endurance, strength of the muscles directly related to foot function and perceived pain, disability and mobility limitations as measured by the FFI in elderly subjects.

Material and methods

This study was carried out on thirty nine retirement home residents with an average age of 74.36±7.71 (55-91) years. Informed consent was obtained from all subjects. Subjects without significant disease were evaluated. (Some subjects had chronic conditions such as arthritis and hypertension but the subjects had no life threatening or disabling conditions such as cardiac dysfunction or cerebrovascular accident and sequential equinus deformity or recent operations).

Structural foot deformities such as pes planus, hallux valgus, hallux limitus-rigitus, claw, hammer and overriding toes, fallen transverse arch, pes valgus-varus, cavus were assessed to reveal the impact of structural foot deformities. A composite scoring method that takes into account the number of structural deformities, the severity, flexibility versus rigidity and prevalent symptoms was utilized. Those aspects of the deformity were graded so that each deformity was given a score ranging from one to three. This grading was done with mutual agreement of two physiotherapists who had 10 and 7 years experience in podiatric physiotherapy according to printed guidelines and when feasible goniometric and metric measurements.[7-10] The deformities were summed up to give a deformity score for each patient out of a worst possible score of 24 since it is not possible for some deformities such as pes cavus and pes planus to be present at the same time. Both feet were assessed and the total score divided by two.

While assessing gait speed subjects were told to wear comfortable walking shoes for the test session. Gait speed was measured as each subject walked to and forth on a marked 50 m walkway. Since gait speed was measured over a considerable distance of 100 meters it is also possible to say that the test also includes endurance as a factor.[6]

The muscle strength of hamstrings, quadriceps, tibialis anterior, tibialis posterior, gastrocnemius, peroneus longus and brevis were measured manually (0-5) and added up thus a total score was obtained (0-30).

Perceived performance was assessed via the FFI. The FFI measures pain and mobility limitation as the effect of foot complaints and problems of foot function. It consists of 23 items divided into 3 scales: Limitation (5 items), Pain (9 items), and Disability (9 items). The items are rated on a VAS consisting of horizontal lines (10 cm) without subdivision. The poles are labeled “never” and “always” (limitations), “no pain” and “intense pain” (pain), and “no difficulty” and “impossible” (disability). The respondent is asked to mark the

horizontal line at the spot that best corresponds to the effect of the foot complaints in terms of limitation, pain and disability. The minimum score is 0 and the maximum 9. If function loss is not a result of foot complaints, the patient is asked to indicate "NA" not applicable. That item is then omitted in further calculations. To calculate the definitive scale scores, the item scores are summed, divided by the maximum possible sum of the item scores, and then multiplied by 100. The total score is the mean of the scale scores. The scores range from 0 to 100; the higher the score, the more limitation/pain/disability present.[11,12]

Statistical analysis:

Data was shown as mean standard deviation (X±SD). The relation between deformity score, total muscle strength, FFI and gait velocity was examined with Spearman rank test. Mann Whitney U test was used to compare age, deformity score, total muscle strength, FFI and gait velocity between men and women. Significance level was set at $p<0.05$.

Results

The study was carried out on 39 healthy elderly (20 women 19 men) with an average age of 74.36±7.71 (55-91) years. The demographic characteristics and assessment results of the subjects are given in Table 1.

No meaningful relation was found between deformity score and muscle strength, FFI, gait velocity ($p>0.05$). While no relationship was found between muscle strength and FFI ($p>0.05$), a significant correlation was found between muscle strength and gait velocity ($r=0.353$, $p=0.032$), and between FFI and gait velocity ($r=0.499$, $p=0.002$). The results are shown in Table 2.

When a comparison was made between genders, while age, weight, FFI and gait velocity values were similar ($p>0.05$), height and muscle strength was higher in men and deformity score was higher in women ($p<0.05$). Although the result of the FFI was considerably higher in women 27.70±22.50 versus men 13.68±19.01 the difference was not significant since standard deviation was also high (Table 3).

Table 1. Demographic characteristics and assessment results of the subjects (N=39).

	X±SDSD
Age (year)	74.36±7.71
Height (cm)	160.64±8.42
Body weight (kg)	66.26±13.76
Total muscle strength (0-30)	27.67±2.61
FFI (0-100)	20.87±21.79
Deformity score (0-24)	6.9±4.75
Gait velocity (m/sec)	1.01±0.35

Discussion

In a study on 417 community dwelling people and 200 nursing home residents Cress et al reported that gait speed was the strongest independent predictor of self-reported physical function.[13] The results of our analysis are consistent with this study. A significant correlation was found between FFI and gait velocity ($r=0.5$, $p=0.002$). The comfortable walking speed of our subjects (1.01 m/sec) also fall into the range reported by Bohannon who found that average walking speed for subjects without known impairments over 60 years of age ranged from 0.60 to 1.45 m/sec for comfortable walking speed and from 0.84 to 2.1 m/sec for fast walking speed.[14] Although men walked faster than women, the difference was not statistically significant.

Our gait speed results are also in concurrence with the results of Steffen and co-workers.[15] Both Bohannon and Steffen et al. measured gait speed as the subjects walked in the central 6 meters of a 10 meter walkway whereas our subjects walked a 100 meter walkway. Therefore our results are implicative of subjects with fairly sufficient endurance and good health.

In our study a significant correlation was found between gait velocity and muscle strength. This is a reasonable, expected outcome although we did not come across a similar study with which we could compare our results.

When we look at other variables a total of 27.70±22.50 out of a worst possible 100 for the FFI; 6.9±4.75 out of a worst possible 24 for foot

Table 2. Correlation between deformity score, total muscle strength, FFI and gait velocity.

	Total muscle strength	FFI	Deformity score	Gait velocity
	r (p)	r (p)	r (p)	r (p)
Total muscle strength	-			
FFI	-0.302 (0.061)	-		
Deformity score	-0.166 (0.312)	0.016 (0.922)	-	
Gait velocity	0.353 (0.032)*	0.499 (0.002)*	-0.009 (0.957)	-

*p<0.05.

Table 3. Gender related data.

	Female (N=20)	Male (N=19)	
	X±SD	X±SD	
Age (year)	75.25±6.90	73.42±8.57	
Height (cm)	155.40±6.01	166.16±6.99	*
Body weight (kg)	63.50±14.83	69.16±12.27	
Total muscle strength (0-30)	26.20±2.29	29.21±1.99	*
FFI (0-100)	27.70±22.50	13.68±19.01	
Deformity score (0-24)	8.6±5.17	5.11±3.57	*
Gait velocity (m/sec)	0.97±0.33	1.05±0.39	

*p<0.05.

deformity score and 27.67±2.61 out of a best possible score of 30 for muscle strength are all implicative of a cohort of elderly subjects who have few medical co-morbidities, are self-reliant in daily activities and are mobile in the community in spite of being retirement home residents.

Gender difference in regards to deformity score with women having significantly more deformities than men and muscle strength are in concurrence with former studies.[15]

We found no correlation between structural foot deformities and the subjects' perception of activity limitation, pain and disability in the FFI which was originally developed in 1991 to measure the impact of foot pathology on function.

This result may be due to several factors. Firstly structural foot problems were not significantly prevalent in our cohort as indicated by a low deformity score. Secondly a larger sample size is necessary for attaining conclusive results.

The last but most important limitation is that we investigated the effect of only structural foot deformities and did not include nail problems such as fungal and ingrown toe nails or corns and calluses which have a considerable impact in foot problems and are highly prevalent in an aging population.[1,2,5,6]

In a 2001 study carried out by Menz and Lord multiple regression analyses revealed that the foot problem score was a significant predictor in the coordinated stability test, stair ascent, and descent and the alternate stepping test; also that subjects with a history of multiple falls had a significantly higher foot problem score.[2]

Unlike our structural foot deformity score they developed a simple assessment form in which foot pain was weighted more heavily than other foot problems, also abnormally thickened nails and hyperkeratotic lesions such as corns and calluses were taken into consideration.

We conclude that, by taking foot pain, nail problems and hyperkeratotic lesions into consideration it will be possible to determine the cumulative effect of multiple foot problems not just structural foot deformities and this will give a more realistic picture of the elderly foot.

In the future it could be interesting to undertake a study which analysis the relation between a more comprehensive foot evaluation scoring system and physical performance tool such as the Aging Life-Space Assessment which reveals what patients actually do and whether assistance is needed.[16] Thus, it may be possible to form clinical hypothesis to explain mobility deficits and design plans of care to address contributing factors in older adults.

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