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Original Article

Effects of hallux valgus deformity on rear foot position, pain, function, and quality of life of women

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Abstract. [Purpose] To investigate the relationship between hallux valgus (HV) deformity and the position of rearfoot joints, and its effects on the quality of life, pain, and related functional status of women with bilateral hallux valgus (HV). [Subjects and Methods] The subjects were 27 right-dominant women. Demographic data, HV angle, weight-bearing and non-weight-bearing subtalar pronation (SP), and navicular height were recorded. Visual Analog Pain Scale, Foot Function Index (FFI), and the American Orthopaedic Foot and Ankle Society (AOFAS) first metatarsophalangeal- interphalangeal (MTP-IP) and AOFAS Mid foot (MF) Scales, and SF-36 were also used. [Results] HV angle, weight-bearing SP, and pain intensity of the left foot were higher. HV angle of left foot was correlated with all sub-scales of FFI, the pain parameter of AOFAS MTP-IP, and pain and total scores of AOFAS-MF Scale. HV angle of the left foot correlated with physical role, pain, and social function sub-domains of SF-36. Right HV angles were correlated with right foot pain and non-weight-bearing SP. [Conclusion] Increasing HV angle and pathomechanical changes in the rear foot are correlated, resulting in increasing pain and thus decreasing functional status as well as decreasing quality of life. Although all the participants were right-dominant, their left foot problems were more prominent.

Key words: Foot, Hallux valgus, Functional status

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INTRODUCTION

Hallux valgus (HV) is a common deformity characterized by angulation of the hallux starting at the first metatarsophalangeal (MTP) joint towards the second toe. Following the angulation of the first metatarsal bone towards the medial side, lateral deviation and internal rotation through the longitudinal axis occur in the hallux. HV is the most common deformity affecting the hallux[1, 2)]. The incidence of HV has been increasing and, if not treated, it may severely impair a patient's functional status. It is a painful, progressive condition and also negatively affects the appearance of the foot[3)].

Intrinsic and extrinsic factors affect the development of HV pathology. Extended or extreme pronation of the rearfoot, acquired pes planus, Achilles contracture, increased joint laxity, metatarsocuneiform joint hypermobility, low transverse arch, familial factors, increase in body weight, gender, cerebral palsy, and stroke are among the main intrinsic factors[4, 5)]. It has been reported that long term activities carried out in a standing position also increase the intensity of pain[1, 3)]. Wearing high heels and shoes constricting the forefoot are among the extrinsic factors that accelerate the development of HV deformity

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and increase its intensity. Therefore, HV has been reported to be more frequent among women and also among individuals living in shoe-wearing societies[6, 7].

Although the underlying mechanisms of HV development have not been not fully elucidated, because it is also seen in non-shoe-wearing societies, it is possible that deformity caused by an underlying mechanism is aggravated by wearing wrong types of shoe, and symptoms may also increase with misuse of shoes[7].

Individuals' daily standing times and daily walking distances as well as the types of platforms on which they stand or walk are important factors affecting the intensity of their complaints as well as determining their physical limitations. Pain is the most important and the most commonly reported HV-related complaint. Pathologies and deformities occurring in the foot, which has an important function in terms of lower-extremity kinematics, cause pain and mobility problems, and may eventually result in insufficiency in physical activity[8].

It is a fact that pain adversely affects the quality of life. Furthermore, it was reported that the quality of life of HV patients complaining of both deformity and pain is more negatively affected than that of HV patients with no symptoms. Menz et al. studied osteoarthritis patients over the age of 55 and reported that increasing intensity of comorbid HV deformity has a negative effect on both general and foot-related quality of life[9]. It was also reported that along with increase in the angulation of the first MTP towards hallux valgus, increase in the intermetatarsal angle also has negative effects on the quality of life[10].

The aim of the present study was to clinically determine bilateral HV deformity, to present its relationship with changes in the position of the rear foot joints, and to determine its effects on the quality of life, pain, and related functional status of women with HV deformity.

SUBJECTS AND METHODS

The study initially included 32 women with clinically diagnosed HV (age range: 20–54 years). Five patients were excluded from the study for various reasons. Therefore, 27 patients completed the study.

Inclusion criteria were as follows: age range of 18–55 years, bilateral deformity with right-dominance, first MTP angle of > 15° as radiologically determined by the referring physician, deformity intensity > 2 based on the Manchester scale, muscle forces on ankle and foot > 4, no history of surgery, and no systemic disease, neurological, cognitive, mental, or psychological problems.

Informed consents were obtained from each participant and also permission from the local ethics committee was obtained (LUT 09/37-26).

Demographic data (age, height, and body weight), symptoms accompanying deformity (hallux bunion and flatfoot), and familial HV history were recorded. All patients included in this study were right-dominant. The reason for this was because right-dominant people form the majority (90%) of the general population[11] and the preferred cerebral lateralization status is related to foot and hand dominancy. In order to confirm the lower extremity dominancy of the participants, they were asked to stand still before stairs. Then, they were commanded to climb and the first foot they used was recorded. The patients who used their right foot four or more times out of five trials were classified as right-dominant[12].

The Mancester Scale, developed by Garrow, was used to determine the severity of the HV deformity of the participants. On the Manchester Scale, which is a valid and reliable clinical tool, the severity of deformity is determined by comparing the patient's foot with standardized images of feet with four grades of HV and the deformities are classified into four groups, as follows: none (1), mild (2), moderate (3), and severe (4)[13]. After evaluation the scale, patients in group 1 were excluded.

The manual muscle test, developed by Dr. Lovett, was conducted for muscle groups (m. tibialis anterior, m. extensor digitorum communis, m. extensor hallucis longus and brevis, m. triceps surae) that may have an impact on the lower extremity, and thus walking and that cause secondary pathological changes in the foot and ankle. Those participants with a muscle strength lower than 4 were excluded from the study[14].

HV angles were determined by measuring the angle between the axes of the first metatarsal and proximal phalanx at the dorsum of the foot and were recorded as in degrees[15, 16]. The results of goniometric measurement, which is a simple, low-cost, and risk-free measurement method, were found correlate with pain and the inter-metatarsal and inter-phalangeal angle, which are indicators of the level of deformity. It was also presented that this is a valid and reliable measurement method for measuring joint movement[17].

Navicular height (NH) is the elevation of the navicular tuberosity from the ground in the full weight-bearing position[18, 19]. Sagittal displacement of the navicular tuberosity may reflect extreme subtalar joint pronation, and thus insufficient support of the ligaments and muscle tendons in the medial longitudinal arch[20]. Furthermore, it may show the degree of plantar flexion of the talus, which provides stabilization through subtalar joint pronation, on the calcaneus[21]. In the literature, NH has been reported to range between 6 ± 3.4 and 9 ± 4.2 mm. In a sitting position, in the sagittal plane, the difference of the height of the navicular bone between the subtalar neutral non-weight-bearing-position and the 50% weight-bearing position is called the 'navicular drop (ND). In the literature, an NH value of 15 mm or more is accepted as abnormal, and the normal value of ND is about 10 mm[22]. For the NH measurements, the height of the navicular tuberosity from the ground was measured using a caliper and recorded in millimeters. NH values were measured for both the left and right feet in both the weight-bearing and non-weight-bearing positions.

The subtalar angle (STA) used to determine rearfoot rotation (valgus/varus), and is defined as the angle between the longitudinal line dividing the calcaneus midline and the line that bisects the distal third of the leg[20]. Furthermore, STA, which is also defined as the angle between the upper Achilles tendon and the distal extension of the rearfoot in a weight-bearing position to diagnose a normal foot when it is 0–4°, physiological flatfoot when it is 5–20°, and pathological flatfoot when it is over 20°[23]. In the present study, STA values of the patients of left and right foot were measured using a goniometer in both weight-bearing and non-weight-bearing positions. The angular deviations towards varus were recorded as and those towards valgus were positive values recorded as. Visual Analog Scale (VAS) was used to determine the maximum pain level that individuals felt during walking due to HV deformity. The patients were asked to mark the level of pain they felt on 100 mm horizontal line for each foot and the point they marked was recorded in millimeters[24].

To evaluate the function affected by pain and deformity, scales developed by the American Orthopaedic Foot and Ankle Society (AOFAS) with established validity and reliability were used the AOFAS-Hallux Metatarsophalangeal-Interphalangeal (MTP-IP) Scale and the Mid-foot Scale (MF). Using the AOFAS Hallux MTP-IP Scale, the pain around the MTP joint and its related functional impact as well as the alignment of the MTP joint were determined. Using the AOFAS MF Scale, pain, functional status and alignment in the mid-foot region were determined. The score range was from 0 to 100 with lower scores indicating greater deformity[25].

Using the Foot Function Index (FFI), information regarding the level of pain individuals felt during various activities (9 questions), difficulties individuals experience (9 questions), and related activity limitations (3 questions) was obtained. The index has 21 questions in 3 sections and patients are asked to state their condition on a scale of 0 to 10. Section scores are calculated by dividing the total score of each section with the total number of questions included in the section and multiplying the result by 100. Total scores are similarly calculated by adding up all the scores and dividing the total by the number of questions and multiplying the result by 100, and higher scores indicate greater pain/symptom[26].

The SF-36 survey was used to evaluate the participants' health-related quality of life. SF-36 is a self-reported questionnaire which is composed of 36 items classified into 8 domains, namely, vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health. The most distinctive feature of SF-36 is that it measures physical functioning and related abilities. The sub-scales evaluate health on a range from 0 to 100; 0 indicates "poor health" and 100 indicates "good health"[27].

Data were evaluated using SPSS 15.0 for Windows (Chicago IL, USA). The mean and range were used for variables obtained by direct measurement and frequency values were calculated for distributions of the categorical data. Correlation analysis was used to investigate the relationships of HV deformity angle with pain, measurements regarding the position of the rearfoot, function, and the quality of life. Since the data were not normally distributed, Spearman's correlation coefficient was used. Correlation values ≥ 0.4 were considered satisfactory (r ≥ 0.81–1.0 excellent, 0.61–0.80 very good, 0.41–0.60 good, 0.21–0.40 fair, and 0.00–0.20 poor). P values less than 0.05 were considered statistically significant.

RESULTS

The mean age, height and weight of the participants were 40.5 ± 10.3 years, 165.7 ± 4.8 cm, and 69.7 ± 11.1 kg, respectively. Family histories of the patients showed that 16 patients (59.3%) had a family history of HV and 18 patients (66.7%) had a family history of bunions.

Patients' HV angles, levels of pain, NH (weight-bearing and non-weight-bearing) and STA are presented in Table 1.

HV angles, weight-bearing STA values, and the maximum level of pain felt during walking for the left feet of the women with HV were found to be higher. The FFI scores or the participants were the highest for the pain parameter, and the lowest

Table 1. Mean and standard deviation (SD) values of the measures (n=27)

			Mean ± SD
Hallux valgus angle (°)	Non-weight-bearing	Right	29.6 ± 7.1
		Left	34.1 ± 6.2*
Navicular height (mm)	Weight-bearing	Right	3.4 ± 0.5
		Left	3.4 ± 0.6
	Non-weight-bearing	Right	4.0 ± 0.6
		Left	4.1 ± 0.5
Subtalar angle (°)	Weight-bearing	Right	8.0 ± 2.9
		Left	9.1 ± 2.9*
	Non-weight-bearing	Right	−3.6 ± 2.4
		Left	−3.4 ± 2.3
Pain (VAS) mm	During walking	Right	4.5 ± 2.8
		Left	6.2 ± 2.8*

*Significant difference, $p<0.05$

for the activity restriction section. Regarding the AOFAS Hallux MTP-IP and MF results, it was observed that subjects' scores were lower for the Hallux MTP-IP (Table 2).

In the SF-36 survey filled out by the participants, they scored 38.8 ± 8.5 and 35.8 ± 8.9 on the physical and mental component summary measures, respectively (Table 2).

When the correlation of HV angle with pain felt on both left and right feet was calculated, a low positive correlation was observed between the right HV angle and the right VAS value ($p < 0.05$).

No correlations observed between the right and left HV angles and navicular drop, which is the difference between weight-bearing NH and non-weight-bearing NH; however, there was a low negative correlation between the non-weight-bearing right subtalar angle and right HV angle ($p < 0.05$) (Table 3).

When the HV angle was compared with functional scales, such as pain, pain-related functional restrictions, social isolation and alignment, a positive correlation was observed between the left HV angle and 3 subscales of FFI ($p < 0.05$). In addition, there was a positive correlation between the pain parameters of FFI and the right HV angle ($p < 0.05$) (Table 4).

Based on the results of the AOFAS Hallux-MTP-IP and AOFAS-MF Scales, there was a negative correlation between the pain-related measurements of the scales and the left HV angle ($p < 0.05$). Moreover, there was a negative correlation between the left HV angle and the total score of AOFAS-MF ($p < 0.05$) (Table 4).

Table 2. Results of pain-related functional status and quality of life scale (n=27)

		Mean ± SD
Foot Function Index	Pain	45.6 ± 18.5
	Function	39.8 ± 18.2
	Activity restriction	23.0 ± 9.9
AOFAS Hallux MTF-IP Scale	Pain	21.5 ± 8.2
	Function	29.3 ± 5.3
	Alignment	4.8 ± 4.0
	Total	55.5 ± 14.4
AOFAS MF Scale	Pain	24.1 ± 5.7
	Function	28.9 ± 4.8
	Alignment	8.2 ± 1.3
	Total	61.7 ± 8.9
SF-36	Physical function	36.1 ± 9.6
	Physical role	37.9 ± 9.2
	Pain	37.9 ± 8.5
	General health	37.9 ± 10.9
	Vitality	36.8 ± 9.8
	Social function	37.6 ± 10.7
	Emotional role	33.8 ± 11.9
	Mental health	35.9 ± 8.4
	Physical component summary	38.8 ± 8.5
	Mental component summary	35.8 ± 8.9

Table 3. Relationship of HV angle with pain, ND, and STA

Hallux Valgus Angle			Right	Left
			r	r
Pain	Non-weight bearing	Right	0.408*	−0.012
		Left	−0.248	0.101
Navicular drop		Right	0.200	0.047
		Left	0.049	−0.054
Subtalar angle	Weight-bearing	Right	0.362	0.049
		Left	0.001	0.199
	Non-weight-bearing	Right	−0.425*	−0.218
		Left	−0.349	0.025

*$p < 0.05$

There was no correlation between the physical and mental component summaries of SF-36 and HV angle ($p > 0.05$); however, there was a mild negative correlation between sub-domains of SF-36, namely physical role ($r=0.433$, $p= 0.024$), pain($r = -0.534$, $p= 0.004$) and social function($r = -0.499$, $p= 0.008$), and HV angle ($p <0.05$).

DISCUSSION

HV deformity is the most common painful condition affecting the foot and causes functional restrictions. Most studies of HV patients have reported the results of interventions to decrease deformities and surgical treatments. However, evaluation of the functional status of patients has been gaining importance. Therefore, our focus was on the effects of HV deformity on pain, rearfoot mechanics, functional status and quality of life.

We included only female HV patients because it is known that HV is more prevalent among females than among males. This difference in prevalence may be due to tight shoes being preferred by females as well as structural differences[1, 3]. Roddy et al. investigated the relation between age and HV in women and found that, compared to the below-40 age group, HV prevalence was 1.76 times higher in the 40–49 age groups and 3.5 times higher in the 50–59 age groups[6]. Studies have shown that HV deformity becomes more prevalent in older age groups[28]. The mean age of the participants in the present study was 40.5 ± 10.3 years. Although HV is more prevalent in older age groups, the high prevalence that we observed in this young adult group, although the number of subjects in this study was not large enough to draw a conclusion, was surprising. The reason for this finding may be that the incidence and onset of deformities have been shifting towards younger ages in industrializing societies. It may also be related to increasing body weight and decreasing functional activity.

In the present study, based on the determination of the position of the navicular bone with respect to the Feiss line, all of the participants were found to have flatfoot with varying degrees from mild to severe. Furthermore, based on the results of STA and NH, which are used to investigate the rearfoot mechanics, we found rearfoot over-pronation in the weight-bearing position in most of the participants. Wong reported that flatfoot, which is caused by posterior tibial tendon dysfunction, causes abductor hallucis muscle dysfunction and thus prolonged and excessive pronation occurring in the subtalar joint results in structural flexibility in the foot, which results in the vulnerability of the foot to mechanical forces and shocks[29].

Although our hypothesis was that angular values of the left and right feet and related parameters would not differ from each other, interestingly, the HV angle and STA/VAS results show that the pathology of the left foot was more severe in the participants of the present study. The severity of deformity of the left foot may be associated with the fact that all participants were right-dominant. This result may mean that, in right-dominant patients the left foot is subjected to different load patterns and thus its load-handling capability is lower, and because of that it is prone to deformity. Although the number of patients in this study was not sufficient enough to draw conclusions, the results highlight the importance of not ignoring the left foot in right-dominant patients. However, the result that angular values obtained for the left foot were higher than those of the right foot and that the increase in these values negatively affects the rear foot position, functional status, and quality of life, supports our hypothesis. In other words, the increase in the HV angle differentiates the left foot with regard to three sub-scales of FFI, total scores of AOFAS Hallux MTP-IP and AOFAS-MF, and the physical role, pain, emotional role sub-domains of SF-36 indicating a decrease in functional status and the quality of life.

In the present study, the results for the dominant foot demonstrate that the level of deformity in the foot that is dominant in functional activities and related functions and quality of life are affected less than expected. On the other hand, the results for the non-dominant foot show increase in HV deformity angle yields increased pain, and foot-specific functional status and general quality of life deteriorate due to pain and progressive deterioration in foot biomechanics. When healthcare profes-

Table 4. Correlation between HV angle and function scales

Hallux Valgus Angle		Right	Left
		r	r
FFI	Pain	0.515*	0.632*
	Function	0.329	0.542*
	Activity restriction	0.238	0.424*
AOFAS Hallux-MTP-IP	Pain	−0.180	−0.580*
	Function	−0.226	−0.167
	Alignment	−0.023	0.047
	Total	−0.184	−0.261
AOFAS-MF	Pain	−0.288	−0.595*
	Function	−0.058	−0.202
	Alignment	−0.302	−0.240
	Total	−0.136	−0.429*

*p < 0.05

sionals who are specialized in foot health, pathologies, deformities and treatment are making a treatment plan for HV, they should approach the patient holistically, and remember that the pathology may affect the patient's physical, emotional and social functions as well as the symptoms they perceive. We think that the results of the present study will guide future studies.

This study had a limited scope as the entire group of participants comprised female cases. Among the limitations of the present study are the low number of patients included in the study and lack of radiological data, which is considered the golden standard in the literature, for determining the level of deformity. These limitations should be addressed in future studies.

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