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Relationship between pedographic analysis and the Manchester scale in hallux valgus

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Objective: The aim of this study was to evaluate the correlation between the Manchester scale and foot pressure distribution in patients with hallux valgus deformity.

Methods: The study included 152 feet of 87 patients with hallux valgus and a control group of 391 feet of 241 individuals without hallux valgus deformity. The severity of hallux valgus was determined using the Manchester scale grading system. Plantar loading patterns in 10 foot areas were determined for all participants.

Results: According to the Manchester scale, 72% of the participants had no, 12.9% mild, 10.7% moderate and 4.4% severe deformity. The Manchester scale grade was highly correlated with both hallux valgus angle and first intermetatarsal angle (p=0.00). Significant differences between the four grades were present for mean pressure under the hallux and the first and second metatarsal heads only (p=0.00). The load distribution under these areas was higher as the hallux valgus progressed from mild to more severe. In all groups, the highest pressure was observed under the second metatarsal head.

Conclusion: The Manchester scale was strongly associated with both the hallux valgus angle and the first intermetatarsal angle. The progression from mild to moderate and severe deformation is associated with peak pressure raise at the hallux, first and second metatarsal heads. The Manchester scale appears to be a useful tool to provide information for the degree of deformity and the pressure under painful foot areas.

Key words: Hallux valgus; hallux valgus severity; the Manchester scale; pedographic analysis.

Hallux valgus occurs with lateral deviation of the great toe and medial deviation of the first metatarsal bone. The deformity is commonly characterized by progressive subluxation of the first metatarsophalangeal joint.[1] The condition occurs in almost 16% of the population over the age of 60 years.[2] Radiographic assessment of hallux valgus includes the evaluation of the hallux valgus and first intermetatarsal angles.[3] Hallux valgus angle of less than 15 degrees and first intermetatarsal angle of less than 9 degrees are considered normal.[4]

The classification of hallux valgus can be classified as mild, moderate or severe. Mild hallux valgus deformity is characterized by a hallux valgus angle of less than 20 degrees and a first intermetatarsal angle of 11 degrees or

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less. A moderate deformity is characterized by a hallux valgus angle of 20 to 40 degrees and a first intermetatarsal angle of less than 16 degrees, while a severe deformity is characterized by a hallux valgus angle of more than 40 degrees and a first intermetatarsal angle of 16 degrees or more.[1] Radiographic evaluation of the deformity is not always feasible or necessary. Various classification methods such as drawing around the foot[5] or the contour measurement of the foot using tapes[6] has been proposed. In 2001, Garrow et al.[7] developed the Manchester scale for the evaluation of hallux valgus severity. This clinical method uses a standardized set of foot photographs and describes four levels of hallux valgus: none, mild, moderate, and severe.

Hallux valgus is a progressive disorder and the foot pressure distribution of different stages of hallux valgus remains controversial.[8,9] The majority of previous studies have reported increased load transfer from the great toe and the first metatarsal to the lateral foot in patients with hallux valgus.[10,11] At the same time, some authors have demonstrated increased load pressure under the hallux.[9]

The aim of this study was to evaluate the correlation between the Manchester scale and foot pressure distribution in patients with hallux valgus deformity.

Patients and Methods

The study included 152 feet of 87 patients (74 females, 13 males; mean age: 57 years, range: 26 to 78 years) with hallux valgus and the control group included 391 feet of 241 individuals (182 females, 59 males; mean age: 51 years, range: 24 to 76 years) without hallux valgus deformity. All patients were part of a larger study of hallux valgus radiological evaluation. Mean body mass index was 23.59 in the hallux valgus group and 24.13 in the control group. Hallux valgus severity was evaluated using the Manchester scale by a second independent physician. Evaluation was performed using the original photographs from Garrow et al.'s study. Drawings of the foot were taken (Fig. 1). Patients stood in the full weight-bearing position and the degree of hallux valgus was recorded as none, mild, moderate or severe.

Plantar loading patterns were determined on all individuals in the hallux valgus and the control group as they stood barefoot across a pressure platform (Foot Checker; Letsense Group – Loran Engineering, Bologna, Italy). The measuring software of the pelmatographer was the Biomec 2011 (Letsense Group – Loran Engineering, Bologna, Italy). Pressure was measured under the hallux (T1), the second to fifth toes (T2-5), the first metatarsal head (M1), second metatarsal head (M2), third metatarsal head (M3), fourth metatarsal head (M4), fifth metatarsal head (M5), middle foot (MF), lateral heel (LH) and medial heel (MH) (Fig. 2).

Hallux valgus angle and first intermetatarsal angles were measured using a goniometer placed directly on the radiograph. Deformities were described as mild (hallux valgus angle of less than 20 degrees and first intermetatarsal angle of 11 degrees or less), moderate (hallux valgus angle of 20 to 40 degrees and first intermetatarsal angle of less than 16 degrees) and severe (hallux valgus angle of more than 40 degrees and first intermetatarsal

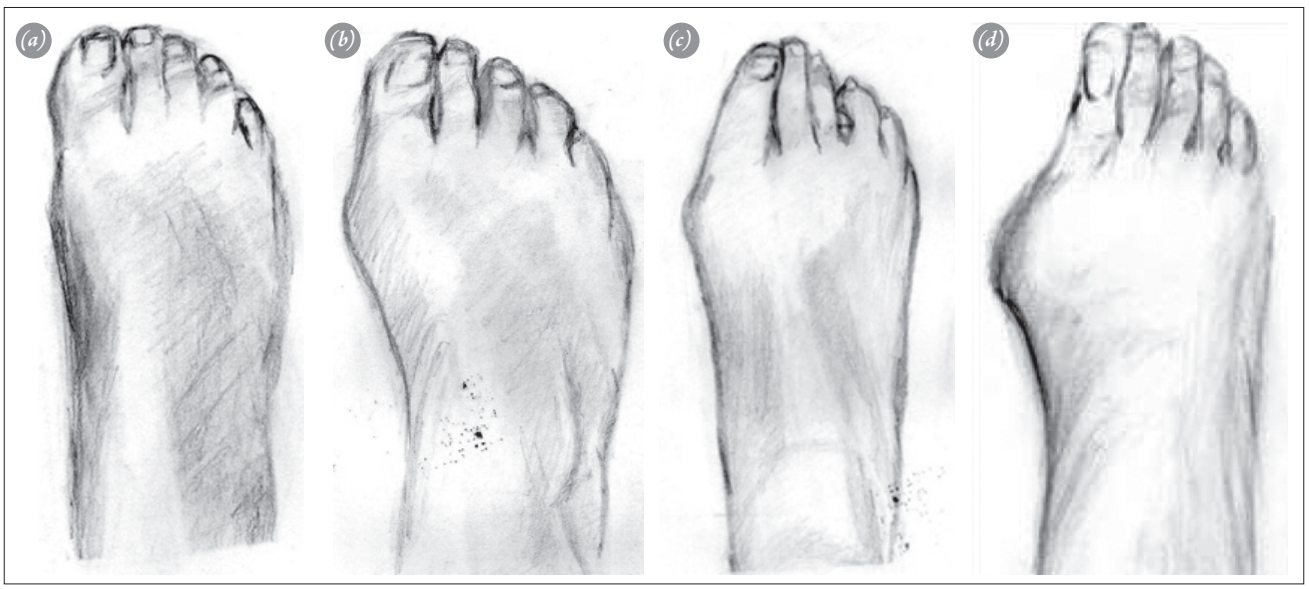

Fig. 1. Drawings of the foot showing **(a)** no, **(b)** mild, **(c)** moderate and **(d)** severe hallux valgus deformity.

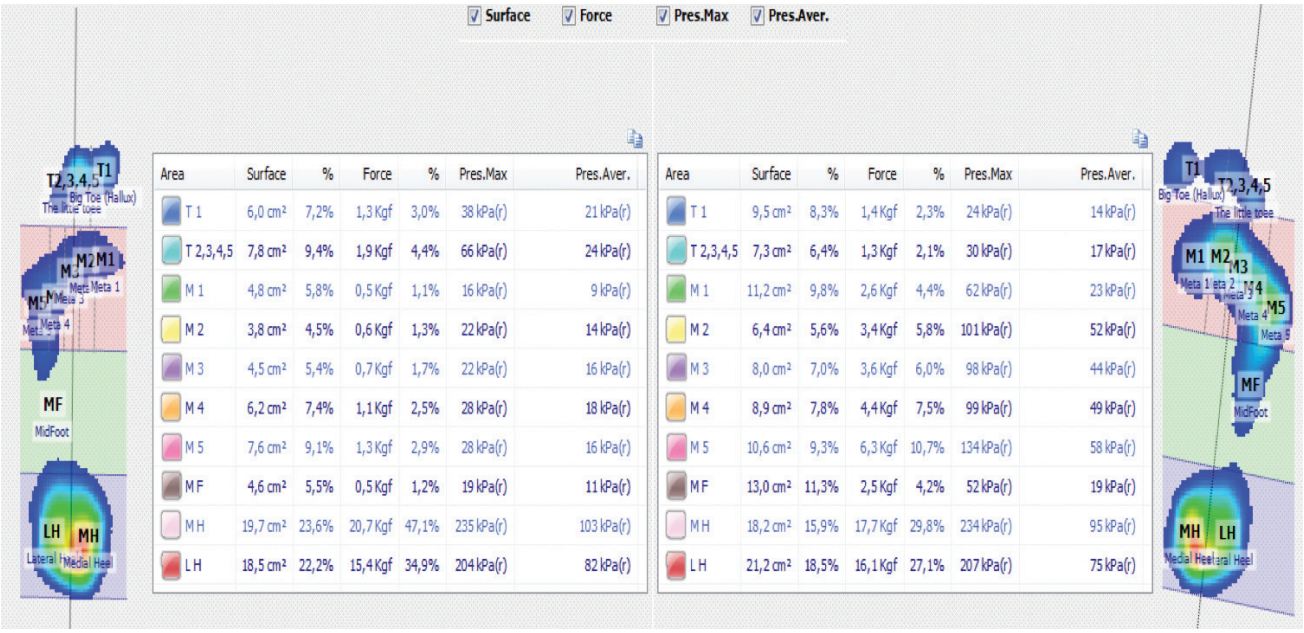

Fig. 2. Pressure measured under different regions of the foot. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

angle of 16 degrees or more). Radiographs taken from 91 healthy feet were excluded from the study because of low quality and technical mistakes.

Data analysis was performed using the SPSS v18.0 (SPSS Inc., Chicago, IL, USA) software. The Kolmogorov-Smirnov and Shapiro-Wilk tests were employed to determine whether the data were normally distributed. For data analysis, the Pearson correlation and the non-parametric Kruskal-Wallis and Mann-Whitney U tests were used. Means and standard deviation of variables were recorded for their descriptive statistical analysis. A p value of less than 0.05 was considered statistically significant. The confidence interval was 95%.

Results

According to the Manchester scale, majority of the participants (72%) were classified as having no deformity, while 12.9% were classified as mild, 10.7% as moderate and 4.4% as severe deformity. Group classifications can be seen in Table 1.

The Manchester scale was highly correlated with both the hallux valgus angle and the first intermetatarsal angle (Table 2). The hallux valgus angle and first intermetatarsal angle differed significantly between all deformity groups ($p<0.05$) (Table 3).

Mean pressure values under the hallux, second to fifth toes, first metatarsal head, second metatarsal head, third metatarsal head, fourth metatarsal head, fifth metatarsal head, middle foot, lateral heel and medial heel based on

Table 1. Distribution of the deformities according to the Manchester scale grading system.

Deformity grade	Number of feet	Incidence
None	391	72.1%
Mild	70	12.9%
Moderate	58	10.7%
Severe	24	4.4%

Table 2. Mean hallux valgus angle (HVA), first intermetatarsal angle (IMA) and standard deviation values in all four Manchester grades.

Deformity grade	HVA	IMA
	Mean±SD	Mean±SD
None	11.69±1.79	6.95±1.67
Mild	23.39±4.09	11.21±2.21
Moderate	33.09±3.26	14.07±2.58
Severe	44.96±4.04	16.88±4.47

Table 3. According to the Mann-Whitney U test results, the hallux valgus angle and the first intermetatarsal angle differed significantly between the groups.

Deformity grades	Hallux valgus angle (p)	First intermetatarsal angle (p)
None vs Mild	0.000	0.000
Mild vs Moderate	0.000	0.000
Moderate vs Severe	0.000	0.014
None vs Moderate	0.000	0.000
None vs Severe	0.000	0.000
Mild vs Severe	0.000	0.000

Table 4. Mean pressure values under the hallux (T1), second to fifth toes (T2, 3, 4, 5), first metatarsal head (M1), second metatarsal head (M2), third metatarsal head (M3), fourth metatarsal head (M4), fifth metatarsal head (M5), middle foot (MF), lateral heel (LH) and medial heel (MH) based on the Manchester scale.

Deformity grade	T1	T2, 3, 4, 5	M1	M2	M3	M4	M5	MF	MH	LH
None	7.54	5.24	55.18	73.10	64.21	59.35	39.50	61.41	99.39	89.70
Mild	41.39	7.31	64.30	74.33	49.08	63.56	48.01	35.63	78.31	70.43
Moderate	60.41	4.60	84.22	91.55	59.10	61.76	41.91	28.50	80.03	70.66
Severe	75.67	6.58	110.67	124.67	61.29	54.79	41.58	34.88	75.50	69.08

Table 5. According to the Mann-Whitney U test results, mean pressure values under the hallux (T1) and first metatarsal head (M1) differed significantly between all deformity groups.

Deformity grades	T1 (p)	M1 (p)
None vs Mild	0.000	0.003
Mild vs Moderate	0.000	0.000
Moderate vs Severe	0.000	0.000
None vs Moderate	0.000	0.000
None vs Severe	0.000	0.000
Mild vs Severe	0.000	0.000

Table 6. According to the Mann-Whitney U test results, the pressure under the second metatarsal head (M2) differed between the groups as follows.

Deformity grade	M2 (p)
None vs Mild	0.400
Mild vs Moderate	0.000
Moderate vs Severe	0.000
None vs Moderate	0.000
None vs Severe	0.000
Mild vs Severe	0.000

Table 7. Positive correlations between the hallux valgus angle (HVA), the first intermetatarsal angle (IMA), and the pressures under the first metatarsal head (M1), the second metatarsal head (M2) and hallux (T1) were found with the Pearson correlation analysis.

	M1	M2	T1
HVA	r=0.779	r=0.792	r=0.824
IMA	r=0.465	r=0.467	r=0.417

the Manchester scale are given in Table 4. Mean pressure under the hallux and the first metatarsal head differed significantly between all deformity groups ($p<0.005$) (Table 5). Mean pressure under the second metatarsal head differed significantly between all deformity groups ($p<0.005$) except between the healthy feet and feet with mild deformity (Table 6). The load distribution under the hallux and the first and second metatarsal heads was higher when the hallux valgus progressed from mild to more severe. Mean pressure under the hallux without deformity was 7.54 kPa and increased to 41.39 kPa in mild, 60.41 kPa in moderate and 75.67 kPa in severe deformity. In the same way, the load distribution under the first and second metatarsal heads increased as the deformity worsened. In all mild, moderate and severe deformity the highest pressure was observed under the second metatarsal head (Table 4).

Strong positive correlations were found between the hallux valgus angle and pressures under the first metatarsal head, the second metatarsal head and the hallux. Moderate positive correlations were found between the first intermetatarsal angle and the pressures under the first metatarsal head, the second metatarsal head and the hallux (Table 7). Mean pressure increased with the value of the angle.

Discussion

The Manchester scale scores were strongly associated with both the hallux valgus angle and the first intermetatarsal angle. The same strong correlation between both angles and the Manchester scale was found in a previous study by D'Arcangelo et al.[12] Menz and Munteanu[13] also reported the same strong correlation, but only for the hallux valgus angle. The authors reported weaker association for the first intermetatarsal angle.

Previous studies have reported controversial results regarding pressure distribution in patients with hallux valgus. Waldecker[8] reported greatest pressure values in the lateral forefoot, the medial toe, the medial forefoot and the lateral toes in patients with hallux valgus. In his study, which did not contain a control group, radiologic parameters were not correlated with pressure characteristics of the forefoot and the data reported for the highest pressures values at the hallux, the second and third metatarsals in healthy feet were based on previous reports by other writers. Martinez-Nova et al.[9] reported a significantly higher peak pressure under the hallux in patients with mild hallux valgus deformity compared to a control group. In both the control and hallux valgus groups, the peak pressure was found under the second

metatarsal head. Pain, alignment and total AOFAS score were related to the mean pressure under the first metatarsal head. In another study by the same authors, the peak pressure in the hallux valgus group was found under the hallux and the first metatarsal head.[14] Plank reported a non-significant correlation between the hallux valgus angle and the pressure under the first, second, and the third metatarsal head.[15] Moreover, Ferrari and Watkinson demonstrated no statistically significant correlation between the hallux valgus angle and the pressure under the hallux.[16]

The current study found a strong correlation between the severity of hallux valgus as evaluated using the Manchester scale and the peak pressures under the hallux, the first metatarsal head and the second metatarsal head. As hallux valgus is a progressive disorder, it appears that the progression from mild to moderate and severe deformity is associated with increases in peak pressure at these areas of the foot. We believe that this finding is related to the hallux pronation and the medial sesamoid subluxation beneath the first metatarsal head, as it is well known that the progression of the deformity from mild to severe is related with the progressive subluxation of the medial sesamoid.[1] Cho et al. reported a relationship between moderate or greater hallux valgus and pain and decreased function.[17]

In conclusion, the Manchester scale appears to be a useful grading method for determining the severity of hallux valgus in a clinical setting and correlate with the peak pressure distribution beneath the hallux, first and second metatarsal heads. We can assume that pain and other foot disorders in patients with moderate or severe hallux valgus disorder can be associated with increases in peak pressure.

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Conflics of Interest: No conflicts declared.

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