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Heel pain in female patients with early knee osteoarthritis

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Abstract

Background: Multiple lower limb joint involvement is one of the most common and debilitating musculoskeletal conditions, while the complaints from both heel and knee pain are considered the most frequent. For that reason, in this cross-sectional study, the association between heel pain (HP) and early knee osteoarthritis (EKO) was investigated; the most painful site and side of HP, the prevalence, and risk factors for disabling HP in patients with EKO were identified.

Results: Bilateral HP (56%) and posterior HP (54%) were found to be the most prevalent complaints, and 66% of patients reported the HP to be non-disabling. There was a very high positive statistically significant correlation between the Manchester Foot Pain Disability Index (MFPDI) and both the Health Assessment Questionnaire (HAQ) and the total Western Ontario and McMaster University Osteoarthritis (WOMAC) score ($p \leq 0.001$), while there was a high negative statistically significant correlation between MFPDI and quadriceps angle of the most affected knee ($p = 0.002$). A higher total WOMAC score (OR 1.077, 95% CI 1.014 to 1.145) significantly increases the risk of developing disabling HP, while wearing 2–3-cm heels during the past month was found to be protective against the development of disabling HP (odds ratio < 1).

Conclusion: Disabling HP was present in a third of patients with EKO and HP, and it was associated with flat shoe wear as well as a high total WOMAC score. Also, it had a statistically significant correlation with varus knee mal-alignment. Furthermore, decreased functional ability in the presence of HP was found to lead to significant disability. Moreover, a striking finding in this study was the longer mean duration of HP compared to the duration of knee symptoms.

Keywords: Early knee osteoarthritis, EKO, Heel pain, Disabling heel pain, WOMAC, Q angle

Background

Multi-joint pain is a common presentation in musculoskeletal diseases, with the commonest and most debilitating being the association and involvement of multiple lower limb joints [1].

Ankle and foot pain and knee pain share similar risk factors including aging [2, 3], occupation [3, 4],

obesity [3, 5], and inappropriate shoe wear [6]. Several mechanisms have been proposed to link the two conditions [7, 8], one of which is multi-joint or generalized osteoarthritis (OA) [1].

Another suggestion was that painful foot conditions either increase rotational stress on the ipsilateral knee joint [8] or shift weight away from the ipsilateral limb increasing loading on the contralateral knee [7]. So, patients with foot and ankle pain may alter their gait pattern to decrease pain, predisposing to KOA [7, 8].

A third suggestion is that the abnormal foot morphology is a protective compensatory mechanism adopted to decrease knee loading and pain. It is well known that

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synchronized movements of the foot and ankle during gait are crucial for normal ambulation. They play a major role in shock absorption and accommodation of rotation of the lower limb. Any delay or failure in such function can predispose to serious injuries [9].

Early recognition of painful knee conditions including knee osteoarthritis (KOA) [10], as well as heel pain (HP), is of significant importance as they are both linked to problems of mobility and gait, and ending in significant disability [11].

Most researchers usually investigate a single joint involvement, which is usually not the case in real life. In this study, the association between HP and early knee osteoarthritis (EKOA) was investigated; the most painful site and side of HP, the prevalence, and risk factors for disabling HP in patients with EKOA were identified and correlated with demographic characteristics of the patients and clinical characteristics of KOA.

Methods

Studied patients

This cross-sectional study included 100 female patients diagnosed with EKOA, based on the Luyten classification (2018) [12], and complained of HP in an institutional setting over a period of 1.5 years.

Exclusion criteria

Patients were excluded if they had a history of foot, ankle, or knee joint trauma or surgery; received knee, ankle, or heel injection in the past 3 months; and had a secondary cause of KOA, established or advanced KOA, or knee pain related to other musculoskeletal or rheumatological conditions.

Ethics approval and consent to participate

All participants were informed about the nature of the study, and a written consent was taken from all of them. The ethical committee and the department approved the study, and the research was conducted in accordance with the Declaration of the World Medical Association of Helsinki [13].

Study design

Demographic data was recorded from all patients, body mass index (BMI) calculation, full history taking, and musculoskeletal assessment of the lower limbs. The quadriceps angle (Q angle) was measured using the goniometric method in degrees [14]. It is the angle formed between a line drawn from the center of the patella to the anterior superior iliac spine (longitudinal axis of the femur) and another line drawn from the center of the tibial tuberosity and the center of the patella [15].

Knee pain was assessed by the pain visual analogue scale (VAS) [16], and the most painful knee was selected

as the index knee. The pain VAS is a horizontal line 100 mm in length, anchored by two verbal descriptors, “no pain” (score of 0) and “worst imaginable pain” (score of 100) [16]. The patients marked the severity of their pain on the horizontal line. Patients’ functional ability was assessed by the health assessment questionnaire (HAQ) [17] and the Western Ontario and McMaster University Osteoarthritis (WOMAC) score [18]. The HAQ consists of 20 questions in eight categories which represent a comprehensive set of functional activities of both upper and lower limbs in the past week [17], while the WOMAC is a questionnaire for the assessment of the affected knee(s) in the last 48 h consisting of three different subscales for the assessment of pain, stiffness, and physical function [18].

The location of the most painful site and laterality of HP to the index knee in the past month were recorded on the foot pain manikins [19]. Posterior HP was defined as foot ache or pain and shading the posterior heel (area 26), while planter HP was defined as foot ache or pain and shading the heel (area 25) [19]. HP and disability were assessed by the Manchester Foot Pain and Disability Index (MFPDI) [20]. MFPDI is a self-administered questionnaire that assesses foot-related problems consisting of four categories: pain intensity, functional limitation, personal appearance, and limitation in work or leisure activities [20]. Patients were divided into two groups according to MFPDI: group 1 with non-disabling HP and group 2 with disabling HP.

Digital X-rays of the ankles and knees (anteroposterior and lateral views) were done. Radiographic grading of KOA was done using the Kellgren and Lawrence (KL) grading scale [21], and only patients with grade 1 KL scale were included in this study. Heel spurs were classified as plantar or insertional calcaneal spurs.

Statistical analysis

Statistical analysis was done using IBM SPSS software version 20.0. A comparison between the two groups was done (group 1 with non-disabling HP and group 2 with disabling HP). A chi-square test was used for quantitative variables (age, BMI, and Q angle). In normally distributed qualitative data, an independent *t* test was used (occupation, presence of diabetes mellitus (DM), bursitis and tendinitis, side and site of HP, foot alignment, height of heels worn in the past month, and X-ray findings of the lateral heel). In abnormally distributed data, the Mann-Whitney test was used (parity, duration of knee pain and HP, HAQ and WOMAC scores). Monte Carlo test was used if more than 20% of expected cell counts were < 5 at 0.05 in testing relation between more than two qualitative variables. Correlation between variables was done by Spearman coefficients. Statistical significance was assigned at $p \leq 0.05$.

Because of the multifactorial nature of mechanisms implicated in the development of disabling HP in female patients with EKOAs, factors that have been found significantly associated with the development of disabling HP on one to one analysis basis were further analyzed using the logistic regression model. The model aimed at analyzing the combined differential contribution of a group of independent variables (predictors) on the development of disabling HP in female patients with EKOAs. The logistic regression model was done only for factors that have been found significantly associated with the development of disabling HP.

Results

Patients were collected over a period of 1.5 years. Most patients (51%) were housewives, with a mean age of 43.70 ± 3.32 years and a mean BMI of 34.08 ± 5.87 kg/m² (with 75% having mild/moderate obesity and 23%

being overweight). The mean duration for knee symptoms was 11.72 ± 6.13 months, and for HP, it was 15.40 ± 10.46 months. Most patients (92%) had bilateral EKOAs, while only 8 patients (8%) had unilateral EKOAs.

Bilateral HP was found to be the most prevalent presentation in 56% of the patients, and contralateral HP to the index knee was the least 7%. The most painful area shadowed by the patients on the manikins showed 54% of the patients had posterior HP (area 26) and 46% of patients reported plantar HP (area 25).

Patients were divided into two groups according to MFPSI: group 1 with non-disabling HP (included 66 patients) and group 2 with disabling HP (included 34 patients).

There was no statistically significant difference between the two groups as regards the patients' age, BMI, duration of knee pain, and the duration, site, and side of HP, while there was a statistically significant difference

Table 1 Differences between the two groups as regards their demographic data and medical history

	Heel pain				Test of significant	p
	Group 1 (N = 66)		Group 2 (N = 34)			
	N	%	N	%		
Age (years)						
Mean ± SD	43.39 ± 3.04		44.29 ± 3.77		t = 1.290	0.200
BMI (kg/m ²)						
Mean ± SD	33.33 ± 5.50		35.53 ± 6.37		t = 1.792	0.076
Parity						
Mean ± SD	2.76 ± 1.48		3.32 ± 1.12		U = 850.500*	0.042*
Occupation						
Heavy/manual worker	19	28.8	19	55.9	χ ² = 7.207*	0.027*
House wife	38	57.6	13	38.2		
Employer	9	13.6	2	5.9		
Diabetes						
No	39	59.1	12	35.3	χ ² = 5.085*	0.024*
Yes	27	40.9	22	64.7		
Duration of knee pain (months)						
Mean ± SD	11.08 ± 5.80		12.97 ± 6.62		U = 968.500	0.257
Duration of HP (months)						
Mean ± SD	14.36 ± 10.29		17.41 ± 10.63		U = 920.500	0.137
Side of HP to index knee						
Ipsilateral	28	42.4	9	26.5	χ ² = 2.598	^{MC} p = 0.279
Contralateral	4	6.1	3	8.8		
Bilateral	34	51.5	22	64.7		
Site of HP (manikin)						
Area 26	32	48.5	22	64.7	χ ² = 2.377	0.123
Area 25	34	51.5	12	35.3		

t, p: t and p values for the Student t test for comparing between the two categories. U, p: U and p values for the Mann-Whitney test for comparing between the two categories. χ², p: χ² and p values for the chi-square test for comparing between the two categories. ^{MC}p: p value for Monte Carlo for the chi-square test for comparing between the two categories. HP Heel pain, BMI Body mass index

*Statistical significance at p ≤ 0.05

between the two groups as regards the patients' parity ($p = 0.042$), occupation ($p = 0.027$), and the presence of DM ($p = 0.024$). Group 2 had a higher parity, the majority of patients were manual workers and diabetic (Table 1).

There was no statistically significant difference between the two groups as regards the Q angle of the index knee, while there was a statistical difference between the two groups as regards the presence of bursitis (superficial calcaneal and retrocalcaneal bursitis), tendo-Achilles (TA) tendinitis, foot alignment, height of heels worn during the last month, the lateral X-ray finding of the most affected heel, and the HAQ and the total WOMAC score. It was observed that the presence of bursitis, TA tendinitis, valgus foot deformity, having worn flat heels during the last month, having both planar and insertional calcaneal spurs on lateral X-ray of the most affected heel, and having a higher HAQ and a higher total WOMAC score were significantly more frequent among group 2 patients (Table 2).

There was a very high positive statistically significant correlation between MFPDI and the HAQ scoring as well as the total WOMAC score ($p \leq 0.001$), while there was a high negative statistically significant correlation between MFPDI and Q angle of the most affected knee ($p = 0.002$) (Table 3).

Although several factors were found to be statistically significant contributing factors for the development of disabling HP in female patients with EKOA on one to one analysis, the logistic regression model revealed that the total WOMAC score is a significant predictor for the development of disabling HP. The odds to develop disabling HP increases by 1.077 with each unit increase in total WOMAC score, while wearing 2–3-cm heels during the past month was found to be protective against the development of disabling HP (odds ratio < 1) (Table 4).

Discussion

It was noticed that females were more likely to report disabling musculoskeletal pain and that pain incidence and disability differs according to the body region, with lower limb pain being the most disabling [22]. For that reason, 100 females diagnosed with EKOA and also complained from HP were studied.

A striking finding in this study was the longer mean duration of HP compared to the duration of knee symptoms. This may be explained by the theory that HP is a predisposing factor for KOA, as Paterson et al. found that foot and ankle pain have a major role in and are a potential risk factor for painful knee conditions as well as symptomatic and radiographic KOA [7]. Also, painful foot conditions were found to either increase rotational stress on the ipsilateral knee joint [8] or shift weight away from the ipsilateral limb increasing loading on the

contralateral knee [7]. Similarly, Hamed et al. [23] mentioned that foot pain and structure have been linked to KOA and possible mechanical and clinical effects of the different insole and lateral wedge insoles in the management of KOA. So, patients with foot and ankle pain may alter their gait pattern to decrease pain, predisposing to KOA [7, 8]. But as this study is a cross-sectional one, we can neither confirm nor disprove such finding.

There was no statistically significant difference between the two groups as regards the age and BMI, and no correlations were found between age or BMI and disabling HP. The young mean age for the patients is consistent with that reported by Briggs et al. [2] and Thomas et al. [24] where patients with early and mild OA were younger than those with moderate and advanced OA, and foot and ankle symptoms were commonly found in middle-aged adults. Furthermore, overweight and obesity were reported as the highest risk factors for developing KOA [5], this is consistent with the high percentage (75%) of patients having mild/moderate obesity, and this could be explained by the increased joint loading [5] and inflammatory factors associated with obesity [25]. Although Chatterton et al. [3] reported that disabling HP was associated with increased age and BMI, contrary to our findings, this may be due to the differences in areas of HP studied and that the current study only included patients with EKOA, while excluding patients with moderate or advanced KOA.

Bilateral HP was the most prevalent presentation in 56% of patients; similarly, Paterson et al. [26] showed bilateral foot pain as the most prevalent presentation, as abnormal compensatory mechanisms adopted by patients at the ankle and foot to decrease knee loading and pain could increase loading on both heels. Disabling HP was found in a third of patients (34%); similarly, a high prevalence of disability ranging from 10 to 64% was reported in patients with foot pain [9, 20].

Higher parity, having a manual occupation, the presence of DM, and higher bursitis and TA tendinitis were found to be statistically significantly more common in group 2 than in group 1 patients. This is supported by the increased risk of degenerative musculoskeletal and soft tissue disorders with higher parity found by Bliddal et al. [27]. They explained that with repeated weight load and hormonal changes that occur with multiple pregnancies, the risk of musculoskeletal disorders and its related disability increases [27]. Chatterton et al. [3] also reported that manual workers and diabetics are more likely to experience disabling HP. Manual workers experience a long duration of standing, squatting, or carrying heavy objects for long distances or up a flight of stairs [3]. Also, significant structural and inflammatory sonographic changes in the TA were found in diabetic

Table 2 Differences between the two groups as regards their clinical characteristics, radiographic findings, and functional ability

	Heel pain				Test of significant	p
	Group 1 (N = 66)		Group 2 (N = 34)			
	N	%	N	%		
Q angle of the index knee						
Mean ± SD	15.54 ± 1.52		15.16 ± 1.72		t = 1.109	0.270
Bursitis						
No	56	84.8	23	67.6	χ ² = 4.002*	0.045*
Yes	10	15.2	11	32.4		
Tendinitis						
No	66	100.0	28	82.4	χ ² = 12.390*	FE p = 0.001**
Yes	0	0.0	6	17.6		
Foot alignment						
Normal	51	77.3	15	44.1	χ ² = 15.986***	MC p = 0.001**
Varus	5	7.6	1	2.9		
Valgus	10	15.2	18	52.9		
Heel height						
Flat	22	33.3	28	82.4	χ ² = 21.569***	< 0.001***
2–3 cm	44	66.7	6	17.6		
X-ray of the lateral heel						
Normal	21	31.8	8	23.5	χ ² = 9.721*	MC p = 0.039*
Plantar calcaneal spur	13	19.7	2	5.9		
Haglund deformity	2	3.0	4	11.8		
Insertion calcaneal spur	7	10.6	1	2.9		
Both planter and insertional calcaneal spur	23	34.8	19	55.9		
HAQ score						
Mean ± SD	0.32 ± 0.10		0.41 ± 0.12		U = 677.500*	0.001**
Total WOMAC score						
Mean ± SD	24.55 ± 8.90		34.82 ± 12.51		U = 50.000*	<0.001***

t, p: t and p values for the Student t test for comparing between the two categories. χ², p: χ² and p values for the chi-square test for comparing between the two categories. MC p: p value for Monte Carlo for the chi-square test for comparing between the two categories. U, p: U and p values for the Mann-Whitney test for comparing between the two categories

Q angle quadriceps angle, HAQ health assessment questionnaire, WOMAC Western Ontario and McMaster University Osteoarthritis

*Statistical significance at p ≤ 0.05, **high statistical significance at p ≤ 0.01, ***very high statistical significance at p ≤ 0.001

Table 3 Correlation between MFPDI and other parameters

	MFPDI	
	r _s	p
Q angle of the index knee	- 0.311**	0.002**
HAQ scoring	0.321***	0.001**
WOMAC scoring	0.393***	< 0.001***

r_s Spearman coefficient, Q angle quadriceps angle, HAQ health assessment questionnaire, WOMAC Western Ontario and McMaster University Osteoarthritis, MFPDI Manchester Foot Pain and Disability Index

Statistical high significance at p ≤ 0.01, *statistical very high significance at p ≤ 0.001

patients [28], and both bursitis and tendinitis were found to be common causes of HP, especially in females, and were usually disabling [29].

Most patients (82.4%) in group 2 had worn flat heels in the past month, while most patients (66.7%) in group 1 had worn 2–3-cm heels; also, on multivariate analysis for the parameters affecting disabling HP for the total sample, wearing 2–3-cm heels during the past month was found to be protective against the development of disabling HP. Many authors also discussed the impact of foot wear on both foot and knee pain and disability [6, 8, 30]. Ko et al. [30] explained this by the shifting of plantar pressure from the heel and TA to the medial forefoot on wearing 2–3-cm heels, thus decreasing pain and disability.

Table 4 Multi-variant analysis for factors predictive of or protective against the development of disabling HP in patients with EKOA and HP

Factors	p value	Odds ratio	95% confidence level for odds ratio	
			Lower	Upper
Parity	0.888	1.030	0.684	1.551
Diabetes mellitus	0.253	2.027	0.603	6.809
Heel height	0.008*	0.189	0.055	0.644
HAQ score	0.496	8.483	0.018	3986.2
Total WOMAC score	0.016*	1.077	1.014	1.145

HAQ health assessment questionnaire, WOMAC Western Ontario and McMaster University Osteoarthritis

*Statistical significance at $p \leq 0.05$

More than 60% of patients in both groups had either planter or insertional calcaneal spurs or both, and having both spurs was significantly more frequent in group 2, while planter spurs were more frequent in group 1. Furthermore, the significance of planter spurs is controversial, as they are sometimes asymptomatic, or not considered the primary cause of pain [31]. These findings are consistent with Menz et al. [32] where patients with plantar calcaneal spurs were more likely to also have insertional spurs, and they were related to OA. These inconsistencies in the researchers' findings could be explained by the different types of spurs available in correlation to the angle of growth, where large non-weight-bearing spurs are usually symptomless, while other large weight-bearing spurs are usually painful [33], which are supportive to the current findings.

Increased knee varus was found to increase KOA risk through increasing medial compartmental loading [34] and may also lead to foot mal-alignment, which when modified improves the gait cycle and patients' comfort significantly [35]. Similarly, in this study, disability was statistically significantly correlated with varus knee mal-alignment.

The mean HAQ and WOMAC scores were statistically significantly higher in group 2; a very high statistically significant correlation between the MFPDI and the HAQ and WOMAC scores was found and the total WOMAC score but not the HAQ score was found to be a significant predictor for the development of disabling HP on the logistic regression model. This is a very important finding, as it indicates that even in EKOA [10], decreased functional ability in the presence of HP will lead to significant disability. Paterson et al. [26] also reported KOA symptoms and functional assessments were worse in people with associated foot pain.

The strength of this study was that 100 female patients with both painful heels and knees were assessed clinically and radiographically. The functional ability and the extent of disability were also assessed. From this data, disabling HP was found in a third of patients with EKOA and HP, and the total WOMAC score was found to be a

predictor for the development of disabling HP, while shoe wear (2–3-cm heels) was found to be protective against the development of disabling HP.

Study limitations

- This study included only female patients and patients with both EKOA and HP, so the sex difference and the prevalence of HP in patients with EKOA were not studied.
- It is a cross-sectional study, and a longitudinal study may reveal more information regarding risk factors for disabling HP.
- Future studies using plantar pressure measurement and gait analysis for better assessment of the ground reaction force are needed.
- Also, future studies are recommended with ultrasound examination of the ankle, foot, and knee to define other joint abnormalities that could not be evaluated by X-ray examination.

Conclusions

Disabling HP was present in a third of patients with EKOA and HP, and it was associated with flat shoe wear as well as a high total WOMAC score. Also, it had a statistically significant correlation with varus knee mal-alignment. Furthermore, decreased functional ability in the presence of HP was found to lead to significant disability. Moreover, a striking finding in this study was the longer mean duration of HP compared to the duration of knee symptoms.

Supplementary information

The online version contains supplementary material available at <https://doi.org/10.1186/s43166-020-00043-0>.

Additional file 1. STROBE checklist. A detailed checklist for the study, with page and paragraph number. (DOCX 40 kb)

Additional file 2. Q angle: A diagrammatic photo showing how to measure Q angle. Ortho, G., Limb, U., Limb, L., Us, A. and Us, C (2020) *Bone And Spine. Orthopedic Health, Conditions And Treatment*. [online]

Bone and Spine. Available at: <<https://boneandspine.com/>> [Accessed 25 September 2020]. (JPG 8 kb)

Additional file 3. Abnormal Q angle: A photo showing the comparison between normal and abnormal Q angles. [Sportsinjuryclinic.net](https://www.sportsinjuryclinic.net). 2020. Q Angle & Knee Rehabilitation - [Sportsinjuryclinic.Net](https://www.sportsinjuryclinic.net). [online] Available at: <<https://www.sportsinjuryclinic.net/sport-injuries/knee-pain/q-angle-knee>> [Accessed 25 September 2020]. (JPG 17 kb)

Abbreviations

OA: Osteoarthritis; KOA: Knee osteoarthritis; EKO: Early knee osteoarthritis; HP: Heel pain; BMI: Body mass index; Q angle: Quadriceps angle; VAS: Visual analogue scale; HAQ: Health assessment questionnaire; WOMAC: Western Ontario and McMaster University Osteoarthritis; MFPD: Manchester Foot Pain and Disability Index; KL: Kellgren and Lawrence; DM: Diabetes mellitus; TA: Tendo-Achilles

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Authors' contributions

All authors have read and approved the final manuscript, and all authors have contributed significantly and are in agreement with the content of the manuscript. Concept: MI, HK, and AA. Design: MI, HK, AA, and YA. Definition of intellectual content: MI and AA. Literature search: YA and HA. Clinical studies and experimental studies: YA and HA. Data acquisition: HA. Data analysis and statistical analysis: YA and HA. Manuscript preparation: YA and HA. Manuscript editing: MI, AA, YA, and HA. Manuscript review: MI, AA, and YA. Responsibility for the integrity of the work as a whole from inception to the published article and should be designated as "guarantor": YA

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

All participants were informed about the nature of the study, and a written informed consent was taken from all of them.

The ethical committee Faculty of Medicine, Alexandria University, and the Department of Physical Medicine, Rheumatology and Rehabilitation both approved the study (reference number not available), and the research was conducted in accordance with the Declaration of the World Medical Association of Helsinki.

Consent for publication

Not applicable.

Competing interests

All authors declare no conflicts of interest.

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