

## ORIGINAL ARTICLE

## Foot Posture Characteristics in Medial Knee Osteoarthritis Patients

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### ABSTRACT

**Introduction:** Alteration of foot posture may influence the knee loading, particularly in medial compartment. The purpose of this study was to find the relation of foot postures with clinical finding in medial knee osteoarthritis (KOA).

**Methods:** Subjects with medial KOA who met inclusion criteria were recruited consecutively, in Nursing home on August to October 2018. The foot posture has determined by Foot Posture Index (FPI). The severity of KOA has measured by Kelgreen-Lawrence (KL) grading system, and pain level using numeric rating score (NRS).

**Results:** There were 37 subjects consisted of male and female with normal foot subsequently 17(8.5%) and 3(15%), male and female with abnormal food subsequently 3(15%) and 1(16%). There were 12 (32.43%) of pronated foot, 5 (13.51%) of supinated foot, and 20 (54.06%) of normal foot subjects. The subjects with abnormal foot posture have severe medial KOA ( $p<0.001$ ), while the pain sensation similar between groups ( $p=0.321$ ,  $p=0.688$ ).

**Conclusion:** There was a correlation between foot posture and the severity of medial KOA.

**Keywords:** *Foot posture, Knee osteoarthritis, Foot posture index, Numeric rating score*

## ABSTRAK

**Pendahuluan:** Kelainan postur kaki dapat mempengaruhi beban lutut, terutama pada kompartemen medial. Tujuan dari penelitian ini adalah menemukan hubungan dari postur kaki dengan penemuan klinis pada osteoarthritis lutut medial (KOA).

**Metode:** Subyek KOA medial yang sesuai dengan kriteria inklusi, direkrut secara konsekutif, di Panti Jompo pada Agustus-Oktober 2018. Postur kaki ditentukan dengan Foot Posture Index (FPI). Keparahan KOA diukur dengan Kelgreen-Lawrence (KL), dan level nyeri menggunakan numeric rating score (NRS).

**Hasil:** Terdapat 37 subjek yang terdiri dari pria dan wanita dengan kaki normal 17(8.5%) dan 3(15%), pria dan wanita dengan kaki abnormal 3(15%) dan 1(16%). Terdapat 12 (32.43%) kaki pronated, 5 (13.51%) kaki supinated, dan 20 (54.06%) subjek kaki normal. Subjek dengan postur kaki abnormal memiliki KOA medial yang parah ( $p < 0.001$ ), sementara sensasi nyeri hampir sama diantara kelompok ( $p = 0.321$ ,  $p = 0.688$ ).

**Kesimpulan:** Terdapat korelasi antara postur kaki dan keparahan KOA medial.

**Kata kunci:** *Postur kaki, osteoarthritis lutut, Index Postur Kaki, Numeric rating score*

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## INTRODUCTION

Knee osteoarthritis (KOA) is one of the most common degenerative joint disease and the major cause pain and activity limitation.<sup>1-4</sup> It affects 12.1% of the population aged 60 years in United States and around 15% in Indonesia.<sup>5,6</sup> Medial KOA is the most common type of KOA.<sup>1,2</sup> It caused by the greater loading occurred in medial compartment of knee joint. During walking, medial compartment bears approximately 60-70% of body weight whereas the lateral compartment bears the remaining weight.<sup>5</sup> Moreover, knee joint

loading is highly predicted by knee adduction moment (KAM). The determinants of KAM are magnitude of ground reaction force (GRF) related to a certain point in the center of knee. The origin of GRF is determined at the approximate location of the center of plantar pressure (COP) and transmitted through the kinetic chain of the lower extremity include knee joint,<sup>5,7</sup> that's way any alteration in foot posture can therefore have direct influence on the GRF and tend to have a significant implication on knee load distribution. Since the GRF is not transmitted to knee joint equally between medial and lateral compartment during walking, the load applied to medial compartment 2.5 times greater and that's way medial KOA occurs ten times more frequent than the lateral one.<sup>7,8</sup>

Foot posture has been ascertained to participate to the development of KOA as it may alter the mechanical alignment and dynamic function of knee during most weight bearing activities.<sup>9</sup> Specific

foot posture might cause greater mechanical stress over knee joint.<sup>10</sup> Meanwhile, KOA may also affect foot motion during walking,<sup>10</sup> hence foot posture might play significant role in KOA setting. There are several type of foot postures. According to The Foot Posture Index (FPI), there are three types of foot posture; normal, pronated and supinated feet.<sup>11</sup> Levinger and colleagues stated that people with medial KOA exhibit a more pronated foot compared to controls, as indicated by the FPI, navicular drop and arch index.<sup>9</sup> In line with Levinger, Reilly and colleagues observed similar findings in people with medial KOA using several foot measures.<sup>12</sup> In Surlakar and colleagues's research, they reported that there were 36% participants with pronated foot, 36% subjects with supinated foot and the rest with normal foot and among medial KOA subjects, there were 83.30% subjects have pronated foot.<sup>10</sup>

As foot posture can directly influence the distribution of knee loading in medial KOA patients,<sup>10</sup> a conservative strategy using orthoses and footwears were developed to decrease the medial loading of knee joint. There are various kinds of foot orthoses that have been applied to decrease knee pain and improve functional capacity of the patients suffering from KOA. Several orthoses were recommended include lateral wedged insoles, valgus knee brace and modification shoes.<sup>8</sup> Those were widely used as one of optional conservative treatments particularly in medial KOA to offload the medial compartment of knee.<sup>5</sup>

Previous studies said that those orthoses were able to shift laterally the medial compartment load by reducing KAM.<sup>13-15</sup> However, the effectiveness of orthoses in reducing KAM is still inconsistent in many previous studies.<sup>16</sup> Chapman et al (2011) and Beardsley (2015) used insoles

in their study and stated that the highly varies effects of insoles in medial KOA patients might be related to foot posture.<sup>16,17</sup> Foot characteristic is one of important aspect initially contribute to KOA and its progression.<sup>9</sup> However, Chapman and Breadsley stated several foot types are not expected to provide a good response in reducing KAM such as pes cavus, pes planus and calcaneus varus.<sup>16,17</sup> Furthermore, Sawada et al proved that foot posture influences the effectiveness of orthoses. Medial KOA patients with normal foot were likely had a more positive beneficial after the use of specific orthoses.<sup>18</sup> Despite the genuine importance of understanding foot characteristics of people with medial KOA, only limited KOA studied have included foot posture even though it is very important.<sup>9</sup> Therefore, the purpose of this study was more focused to investigate the prevalence of foot posture in medial KOA patients and their correlation with clinical profiles.

## METHODS

The research protocol was approved by Health Research Ethics Committee, Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo National Hospital and conducted at Cipto Mangunkusumo National Hospital in Indonesia. A cross sectional study was generated on 37 patients who were clinically diagnosed as KOA according to American College of Rheumatology (ACR) criteria and selected by a consecutive technique sampling.<sup>19</sup> We determined as medial KOA based on radiologic findings in combination with osteoarthritic signs according to Kellgren-Lawrence (KL) system of grade 1-3 were located over medial tibiofemoral compartment. Subjects were required to undergo an examination using the numeric rating scale (NRS).<sup>20</sup> Subjects met

with above criteria were recruited as participants, then they were divided in two groups: normal foot and abnormal foot group. The demographic, severity of KOA and pain level were obtained at the same time

To determine types of foot posture, we were using the foot posture index (FPI). This instrument demonstrated good intra-rater reliability (intraclass correlation coefficient (ICC) 1,1 = 0.87) from previous study.<sup>11</sup> The FPI consist of 6 items evaluation: talar head palpation, supra and infra curvature of lateral malleolus, calcaneus inversion/eversion, prominence of talonavicular joint, congruence of the internal longitudinal arch, abduction or adduction of the forefoot with respect to the rear foot. Based on those observations, type of foot posture was categorized into three groups as follows: normal foot (total score between +0 and +5), pronated foot (total score between +6 and +9), and supinated foot (total score between -1 and -4). In present study, the pronated and supinated foot subjects were included as abnormal foot group.

Data were collected included demographic and clinical profiles and analyzed using the Statistical Package for Social Sciences (SPSS) program version 20 for statistical analysis. Some data were presented in percentage and drawn in a table or graphic. We also ascertained whether the results had a normal distribution using Shapiro-Wilk test. Based on this test, the difference of pain level and severity of KOA were compared between two groups by using the appropriate test and presented as means (SDs) or range (minimal-maximal). Statistical significance was set at  $p < 0.05$ .

## RESULTS

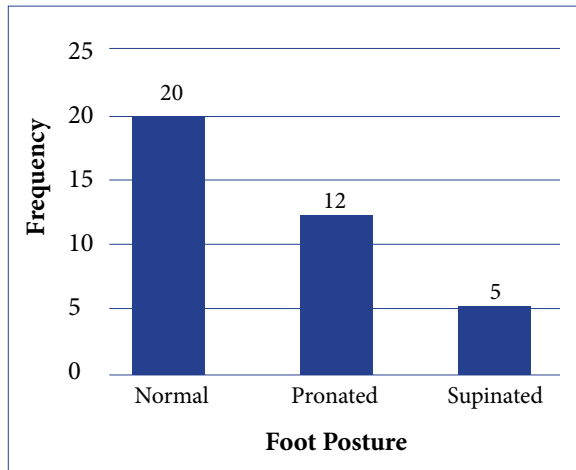
Among 37 participants included in this study, 89.19% participants were female and only 10.81% were male. The average age of the sample was  $60.11 \pm 8.96$  years and dominated by participants with obesity (54.05%). The data are listed in table 1 below.

**Table 1. Baseline demographic characteristics**

Variable	Normal foot n=20, (%), SDs	Abnormal foot n=17, (%), SDs	P values
<b>Age (year)</b>	57,40 ( $\pm 9,81$ )	63,29 ( $\pm 6,79$ )	0,04 <sup>a</sup>
<b>Gender</b>			
Female	17 (85%)	16 (94%)	0,609 <sup>b</sup>
Male	3 (15%)	1(6%)	
<b>Nutritional status</b>			
No obesity	12 (60%)	9 (52,94%)	0,666 <sup>c</sup>
Obesity	8 (40%)	8 (47,06%)	
<b>Occupation</b>			
Housewife/retirement	11 (55%)	17 (100%)	0,002 <sup>b*</sup>
Work outside home	9 (45%)	0 (0%)	

<sup>a</sup>Independent t-test, <sup>b</sup>Fisher exact, <sup>c</sup>Chi square, \*statistically significant  $p < 0,05$ , SDs= standard deviation.

The prevalence of foot posture among medial KOA patients was found to be very variable. The foot posture type is presented in Figure 1. The pronated and supinated foot later will mention as abnormal foot. In this study, range of FPI score for pronated foot between +6 and +8. It means there was no subject categorized as highly pronated, whereas in supinated, all five participants have FPI score -2.



**Figure 1. Type of foot posture among subjects**

Clinical profiles of participants included KL-grading system and pain level. There was no significant different for knee pain level for both groups, but for those with more severe KOA tend to occur in abnormal foot groups ( $p < 0.001$ ).

## DISCUSSION

In many previous studies, there were various strategies for conservative treatments in KOA patients. One of conservative treatment is orthoses and footwears. The efficacy of those orthoses is still a crucial issue.<sup>9,18</sup> Some researcher said that they might be help but others stated vice versa. Despite, the potential benefit of using orthoses in KOA patients, one must fully understand about foot characteristic, since it can alter the mechanical alignment and dynamic function of the lower limb and may therefore be related to the development of lower limb musculoskeletal conditions, included the progression of KOA.<sup>9</sup> Moreover, several recent studies have drawn special attention to the possibility of increasing foot orthoses benefits by assessing more carefully the foot posture.<sup>8,9,16</sup> Assessing foot characteristics of people with medial KOA may therefore advance our understanding of the potential role of foot orthoses and footwear modifications on lower limb alignment and function.<sup>9,18</sup>

In this study, we investigated foot characteristics of people with medial KOA

**Table 2. Clinical profiles**

Variable	Normal foot n=20, (%), SDs	Abnormal foot n=17, (%), SDs	P values
KL grading			
I-II (mild-moderate)	19 (95%)	4 (23,52%)	<0,001 <sup>a*</sup>
III (severe)	1 (5%)	13 (76,48%)	
NRS			
Right knee	4,45 (±1,57)	5,00 (3-8)	0,321 <sup>b</sup>
Left knee	4,85 (±1,95)	5,12 (±2,06)	0,688 <sup>c</sup>

<sup>a</sup>Chi square, <sup>b</sup>Mann Whitney, <sup>c</sup>independent t-test \*statistically significant  $p < 0,05$ , SDs= standard deviation, KL=Kelgreen&Lawrence, NRS= Numeric rating scale

using the FPI. We exhibited a high prevalence of abnormal foot (45.94%). This result was similar with Levinger's, Surlakar's and Reilly's research. Pronated feet were the most frequent among the abnormal foot.<sup>9,10,12</sup> This situation might be a consequence for medial KOA or as risk factor, to date it still cannot be determined yet. Patient with medial KOA tend to have a more varum alignment of the knee.<sup>7,8</sup> This condition caused the trajectory of GRF to pass more medially with the respect to the center of knee joint result in higher KAM which furthered increased load in medial compartment.<sup>7</sup> Previous literature revealed that pronated foot might be as one of compensation strategy performed by patient naturally in order to decrease the pain.<sup>9</sup> Pronated foot more frequent in medial KOA might due to biomechanical changes that occurs during abnormal loading of knee joint during weight bearing activities.<sup>9,10</sup> In order to decrease KAM, foot adapts subtalar joint in to pronated position.<sup>10</sup> Thus, shift the knee load more laterally and further decrease load on medial compartment. However, there were some individual in medial KOA with supinated foot. In Surlakar's study and this present study, there were 11.54% and 13.51% medial KOA patients with supinated foot respectively. Since, there is only very lack data investigated about foot posture in medial KOA patients, we still can't determine the reason behind the phenomena yet. In authors opinion, this could be explained by the fact that there was a possibility of supinated foot did exist before medial KOA was developed.

Another compensation strategy to decrease knee load on medial compartment is gait modification. The KAM can be decrease with

several gait modifications such as increase in ipsilateral trunk lean, medial thrust gait, toeing out, and reducing speed.<sup>7</sup> Those gait modifications can alter COP and reduce the moment arm of GRF. Those are known consistently resulting in decreasing knee KAM particularly in medial KOA.<sup>16</sup> Since the origin of GRF is determined at the approximate location of COP and transmitted through the kinetic chain of the lower extremity include knee joint,<sup>7</sup> that brings any alteration in foot posture can therefore have direct influence on the origin of GRF and tend to have a significant implication on load distribution of the knee. However, whether those kinds of gait modifications can also cause foot deformity or increase progression of KOA must be furthered investigated.

Yasuda and Sasaki used insoles in medial KOA patients and found that insoles gave more benefit only for those medial KOA subjects with mild severity (KL 1-2).<sup>21</sup> Moreover, Chapman predicted only normal foot allows orthoses to raise some biomechanical benefits in order to decrease knee pain.<sup>17</sup> The effect of using orthoses in reducing pain in KOA patients was reported through the mechanism of shifting the COP laterally so that GRF come closer to the center of the knee resulting in decrease of KAM.<sup>13-15</sup> KAM itself in many previous studies were said to be as the strongest predictor that determine greater burden of load over medial knee.<sup>13-15</sup> Chapman and Beardsley predicted that normal foot would have a more significant pain reduction effect in relate to the use of orthoses. They stated that the use of insoles in KOA patients was more effective in subjects with normal foot.<sup>16,17</sup> It might be because normal foot allows the presence of

laterally knee load shifting which is very likely that situation was not occur in abnormal foot. This statement is in line with Sawada et al who conducted a study that identified the magnitude of lateral shifting of COP after the use of insoles in normal and abnormal foot group. The lateral shift of COP and significant KAM reduction were more significant in normal foot than that of abnormal foot.<sup>18</sup> We think the reason why many previous studies have found inconsistent results in reducing pain level after using orthoses might be because mostly those studies did not consider the foot posture, even though it is said to have a vital role in determining whether the lateral shift of COP can occur or not. Based on this, we should consider foot posture as one important aspect in orthoses prescription otherwise the optimal benefit of orthoses couldn't be achieved.

This present study also revealed that medial KOA patient with abnormal foot tend to have a more severe KOA. In agreement with this, Reilly also found for people with severe medial KOA have a more pronated feet compared to control.<sup>9,12</sup> Those with medial KOA commonly with a varum deformity which can worsen the progression of KOA due to there is increase load on medial compartment.<sup>7</sup> Changes in knee alignment would probably modify the normal static and dynamic function of ankle and subtalar joint, lead to abnormality of the foot posture.

In Lukum's study the more severe KOA, the greater pain level will raise. However, in this present study, there was no significant different in pain level for both groups, the abnormal foot with a more severe KOA didn't experience

higher pain level. This discrepancy might be caused by the different characteristic of subjects. In Lukum's study, subjects with KL 3 were dominant whereas in this present study there were only 13 out of 37 subjects with KL 3. Patients with KOA KL3 commonly had a varus deformity.<sup>7,22</sup> Varus deformity is very suggestive for higher medial compartment load and in line with more severe pain.

As aforementioned above, clinicians while evaluating KOA patients should be more careful, not only evaluate pain level but also foot posture itself. In our opinion, foot posture has a vital role in treating KOA patients. Each KOA individuals have their own characteristic and their orthoses or footwears should be specially designed based on those characteristics. Moreover, the highly prevalence of abnormal foot found in this study subsequently implicate a consideration. Assessing foot posture no longer as an optional examination but must include as a routine examination in KOA patients in order to develop a new strategy in treating KOA patients, particularly when provide orthoses and footwears, otherwise the optimal beneficial effect of those orthoses couldn't be achieved.

## CONCLUSION

This present study showed that higher prevalence of abnormal foot was found in medial KOA patients. So, examine individual foot alignment can be suggested as a routine assessment in medial KOA patients in order to develop a suitable orthoses or footwears.



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