

## **The relationship between static foot posture and chronic bilateral knee osteoarthritis among the patients attending Department of Rheumatology and Rehabilitation (General), National hospital, Sri Lanka**

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**Abstract.** Knee osteoarthritis is one of the most common types of arthritis presented in Sri Lanka that deteriorates the quality of life and physical performances of affected individuals. In chronic bilateral knee osteoarthritis, there is a higher possibility to develop deviated foot and ankle characteristics as a result of alterations in the mechanical alignment of lower limbs. Therefore, the main purpose of this study was to evaluate the relationship between static foot posture and chronic bilateral knee osteoarthritis. A descriptive cross-sectional study was conducted under consecutive sampling method including 155 patients within the age group of 40–80, who were clinically diagnosed as bilateral knee osteoarthritis and fulfilled the inclusion criteria at Department of Rheumatology and Rehabilitation (General), National hospital of Sri Lanka. The foot posture was evaluated using two foot measures, Foot Posture Index (FPI) and Staheli Arch Index (SAI). The study included 135 females and 20 males with the mean age of 59.19±8.649 years old. According to the FPI and SAI, altered foot postures were exhibited by 52.3% and 67.7% of the participants respectively. Significant positive correlations ( $P<0.01$ ) were emphasized between chronicity of the condition and each of the foot posture changes. Furthermore, pronation (51.3%) and flatfeet (57.7%) are common among patients who were  $\geq 60$

years. There is a significant difference ( $P<0.01$ ) between foot postural changes of males and foot postural changes of females which were evaluated using FPI while a significant difference was not denoted ( $P>0.05$ ) for foot posture changes which were evaluated using SAI. Altered foot postures are common among chronic bilateral knee osteoarthritis patients in Sri Lanka. Therefore, it is recommended that assessment of foot posture in knee osteoarthritis patients is an essential component in clinical practice in Sri Lanka.

**Keywords:** Chronic Bilateral Knee Osteoarthritis, Foot posture index, Staheli Arch Index

### **Introduction**

Osteoarthritis (OA) is a wear and tear type degenerative disease involving the cartilage and many of its surrounding tissues (Goldring & Goldring, 2006). Knee osteoarthritis (OA) is considered as a common disease which manifests physical, functional, psychological and social burdens in the affected individual. Knee is the most vulnerable joint for osteoarthritis (Blagojevic et al, 2010).

In musculoskeletal conditions of lower limb like chronic knee osteoarthritis, as a result of the alterations in the mechanical alignment, there is a higher possibility to develop abnormal ankle and foot characteristics.

Among these abnormalities, alterations in the foot posture are considerable.

The foot consists of forefoot, midfoot and rear foot which forms a complex system with ankle. The foot typically consists of three arches; medial longitudinal arch, lateral longitudinal arch and a transverse arch. Foot arches perform static and dynamic weight bearing functions (Norkin & Levangie, 2005).

The movements occurring in the foot are as follows.

- Ankle joint - Dorsiflexion, plantarflexion in the sagittal plane
- Subtalar joint - Inversion, eversion in the frontal plane

Abduction, adduction in the transverse plane

Furthermore, these movements occur together as complex combined movements, known as supination and pronation. Pronation is a combined movement of eversion, abduction and dorsiflexion. Supination is a combined movement of inversion, adduction and plantar flexion.

In the optimal erect posture, the ankle joint is in the neutral position, or midway between dorsiflexion and plantar flexion, without any pronation or supination (Norkin & Levangie, 2005).

Flat feet or pes planus is a postural deformity in which the arches of the foot collapse, with the entire sole of the foot coming into complete or near complete contact with the ground (Pranati, Yuvraj Babu & Ganesh, 2017).

Pes Cavus is the increase in the height of the medial longitudinal arch of the foot and it does not become flat on the ground when the person is in the weight bearing position (Troiano, Nante & Citarelli, 2017).

Staheli plantar arch index (SAI) is one of the simple, easy, inexpensive and reproducible, quantitative measurements to determine flat feet. The foot print is obtained using the

Harris mat, and the SAI is calculated from the foot print. Staheli Index refers to the ratio between the minimal distance in the mid foot region and the maximal distance in the hind foot region (Plumarom, Imjaijitt & Chaiphrom, 2014).

Foot Posture Index (FPI) is a clinical tool which has been designed to evaluate the foot posture with a quick and reliable manner. FPI was originally designed with 8 components (FPI-8) based on observations of postural variations of rear foot, mid foot and fore foot. But due to several mismatching and limited reliability, FPI was redesigned and modified with 6 components. Each component was scored from -2 to +2 evaluating the total FPI score as -12 to +12 (Aquino et al., 2018). FPI 6 has manifested metric properties and has a validity of a unidimensional measure of foot posture. (Keenan et al, 2007).

A chronic disease is one lasting 3 months or more according to the definition of United States National center for health statistics (MedicineNet, 2020).

Majority of the patients with knee osteoarthritis experience variety of complications in addition to the symptoms related to the affected knee joint. Therefore, the purpose of this study was to evaluate the relationship between static foot posture with regards to Chronicity, Age and Gender and determine the prevalence of foot posture change among chronic bilateral knee osteoarthritis patients.

### **Materials and Methodology**

A descriptive cross-sectional study was conducted under consecutive sampling method including 155 patients. The study included male and female patients aged between 40-80 years who have been diagnosed with bilateral knee osteoarthritis at Department of Rheumatology and Rehabilitation (General), National hospital of Sri Lanka. The patients who have bilateral knee osteoarthritis for more than three

months were included in the study. Subjective assessment including socio-demographic data and the history of the condition of the participants was obtained using an interview-administered assessment form. The foot posture was evaluated using Foot Posture Index (FPI) and Staheli Arch Index (SAI). Data were statistically analyzed using SPSS software version 23.0.

The latest approved FPI-6 is consisted of six components; each component is scored between (-2) to (+2). The overall posture of the foot was obtained from the total of the measures. The 6 criterions were observed and examined in both feet. The criterions include Talar head palpation, supra and infra lateral malleolar curvature, inversion and eversion of the calcaneus, budging in the region of the TNJ (Talo navicular joint), congruence of the medial longitudinal arch and abduction and adduction of the forefoot on the rear foot.

Normal values for FPI (Al-Bayati, Benlidayi & Gokcen, 2018)

- 0 to +5 indicates neutral foot posture
- $\geq +6$  indicates pronated foot posture
- $< 0$  indicates supinated foot posture

Staheli plantar arch index was calculated by using foot print method (Figure 1). The foot print was obtained using the Harris mat (Cisneros, Fonseca & Abreu, 2010).

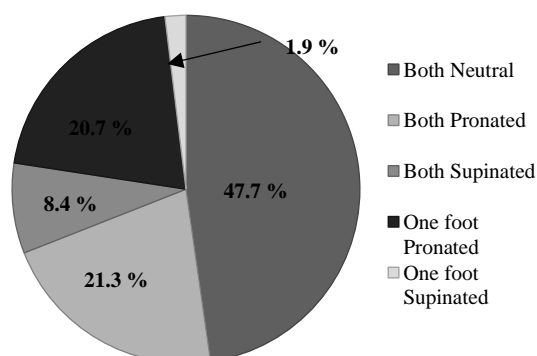


Figure1: Calculation of Staheli plantar arch index (Son et al., 2017)

Calculation of the Staheli plantar arch index

Measurement of the width of the central region (cm) of the foot print was considered as A and the width of the heel region (cm) was considered as B. The Staheli plantar arch index was evaluated by dividing the A value by B value.

$$SPAI = A/B$$

Normal values for Staheli plantar arch index (Son et al, 2017)

- High arch  $< 0.5$
- Normal arch (0.5 – 0.89)
- Low and flat arch  $\geq 0.9$

## Results

The study included 135(87.1%) females and 20(12.9%) males with the mean age of  $59.19 \pm 8.649$  years old. Mean values for FPI, SAI and chronicity (months) are shown in the table 1 below.

Table 1: Mean values for Foot posture index, Staheli arch index and Chronicity

Characteristics	Mean $\pm$ SD	
	Right	Left
FPI	3.79 $\pm$ 3.05	3.61 $\pm$ 3.09
SAI	0.79 $\pm$ 0.29	0.78 $\pm$ 0.30
Chronicity	64.26 $\pm$ 34.31	64.12 $\pm$ 39.26

According to the FPI and SAI, altered foot postures were exhibited by 52.3% and 67.7% of the participants respectively. Distribution of the foot postural changes according to FPI and SAI is shown figure 2 and 3.

Significant positive correlations ( $P < 0.01$ ) were emphasized between chronicity of the disease and each foot postural change including pronation, supination, flatfeet and high arch. Pearson correlation test was used to analyze the above mentioned correlations. Pronation (51.3%) and flatfeet (57.7%) are common among patients who were  $\geq 60$  years. There is a significant difference

( $P < 0.01$ ) between foot postural changes of males and foot postural changes of females which were evaluated using FPI while a significant difference was not denoted ( $P > 0.05$ ) for foot posture changes which were evaluated using SAI according to the Chi Square statistics.

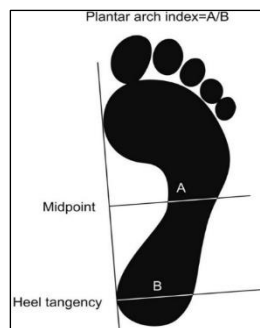
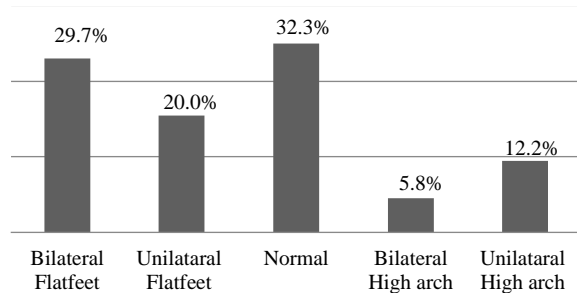


Figure 2: Distribution of the prevalence of foot posture



changes according to FPI

Figure 3: Distribution of the prevalence of foot posture changes according to SAI

## Discussion

The musculoskeletal conditions such as knee osteoarthritis influence the mechanical alignment and dynamic function of the adjacent structures in the whole lower limb. According to the FPI findings of the study, 52.3% of altered foot postures were exhibited at least in one foot in the participants. Previous studies which have been conducted related to this objective have obtained different conclusions. A study conducted by Balci et al (2012) has indicated that people with osteoarthritis manifest a pronated foot type. Though more altered foot postures were exhibited through the above studies, a study done by Al-Bayati, Benlidayi and Gokcen,

(2018) has shown the percentages of neutral, supinated and pronated foot postures as 68.60%, 22.6% and 8.66% respectively which is not in agreement with results of the current study.

The study evaluated the prevalence of flat feet, normal arch and high arch among the recruited group of patients. In accordance with the results, 49.7% of knee OA patients exhibited flat feet at least in one foot. Similar findings regarding the prevalence of flat feet can be found in other publications. A study which has been conducted in Japan by Iijima et al (2017) has determined a percentage of 49.5% of knee OA patients who exhibited flat feet at least in one foot.

The study evaluated the relationship between the presence of foot postural changes including supinated, pronated, flatfeet and high arch foot postures with regards to chronicity of knee OA. The results of this study determined significant positive correlations ( $P < 0.01$ ) between each foot postural change and chronicity.

The study evaluated foot postural changes with regards to the age of the participants. The percentage of participants who exhibit altered foot postures at least in one foot was comparatively high among the patients who were  $\geq 60$  years. When considering the gender, there is a significant difference ( $P < 0.01$ ) in foot postural changes between males and females according to FPI while there is no significant difference ( $P > 0.05$ ) for foot postural changes between males and females according to SAI.

In summary, altered foot postures are exhibited commonly in chronic bilateral knee osteoarthritis patients. According to the point of view of the researchers, those altered foot postures may have occurred due to a compensatory change in the lower limb alignment as the result of the degenerative changes that occur in the knee joint. Foot pronation and supination might be linked to

the affected compartment of the knee joint. However, this fact was not proven by the current study as it did not accommodate the evaluation of radiological evidences. A previous study conducted by Surlakar et al (2017) has described the mechanism of the occurrence of foot pronation and supination.

The pronation of the subtalar joint may be a compensatory movement for the increased load on the medial compartment of knee joint. Increased load on medial compartment can arise due to the rise in adduction moment arm which occurs in medial compartment knee OA. Therefore, foot pronation is a restorative mechanism which is presented as a response to wear and tear cartilage damage in medial knee OA. This compensatory pronation lessens the adduction moment arm of knee by transferring pressure laterally and decreasing the additional load on the medial compartment.

The supination of the subtalar joint may be a compensatory movement for the lateral tibial torsion caused by developed abduction moment of knee joint. This compensatory supination lowers the additional load on lateral compartment of knee joint. Furthermore, several studies have emphasized the possible advantages of footwear modifications and foot orthoses in decreasing the load on the knee joint. Therefore, evaluation of the foot postural changes of patients with knee OA may facilitate the health care professionals' knowledge on the possible role of the footwear modifications and foot orthoses on proper alignment and function of the lower limb (Surlakar et al, 2017). The following literature has emphasized the application of separate wedged insoles considering the affected compartment of the knee joint. For medial knee OA, lateral wedges are suggested and for lateral knee OA, medial wedges are suggested (Hinman & Bennell, 2009). In medial knee OA, there is a rise in adduction moment (Rodrigues et al, 2008). The knee

adduction moment (KAM) is identified as a known risk factor for the progression of knee OA. The use of lateral wedged insoles (LWI) has potential benefits on correcting the KAM, thus correcting the bio-mechanical alignment of the lower limb (Shaw et al, 2017; Rodrigues et al, 2008). In lateral knee OA, frontal loading of knee can be decreased by medial wedges inserted to shoes or amalgamated with ankle orthoses (Hinman & Bennell, 2009).

In summary, when considering the above factors, it is recommended to include a routine foot assessment when assessing knee OA patients in Sri Lankan clinical setting. Foot wear and orthotic modifications are recommended to be implemented as an additional management strategy to correct the altered lower limb alignment and to improve the functionality of chronic bilateral knee OA patients.

### **Conclusion**

The study concluded that significant positive correlations were emphasized between chronicity of the condition and each foot posture changes. Patients who were  $\geq 60$  years were more prone to exhibit pronation and flatfeet. When considering the gender, there is a significant difference in foot postural changes between males and females according to FPI, while there is no significant difference according to SAI. Additionally, altered foot postures are common among chronic bilateral knee osteoarthritis patients in Sri Lanka. Therefore, it is recommended that assessment of foot posture in knee osteoarthritis patients is an essential component in clinical practice in Sri Lanka in order to minimize further complications and introduce corrective orthotic and footwear modifications as an additional management strategy.

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