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Correlation between foot posture index (FPI) and knee osteoarthritis (OA) in elderly individuals

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Abstract
Background: Osteoarthritis (OA) is an age-related disorder and is often described as a chronic degenerative disease. Prevalence rates is estimated that 9.6% of men and 18% of women aged ≥ 60 years have symptomatic OA worldwide whereas in India it is 22% to 39%. Foot Posture Index (FPI) is a diagnostic clinical tool aimed at quantifying the degree to which a foot can be considered to be pronated, supinated or neutral position.
Aim of the study: To determine correlation between Foot Posture Index and Knee Osteoarthritis in Elderly individuals.
Methodology:
Sampling method: Convenient sampling
Study duration: 3 months
Sample size: 100 participants
Result: The Karl Pearson correlation co-efficient(r) for the above study is 0.43, R squared value is 0.18 and the two tailed p value is <0.0001 and thus the result shows extreme significance.
Conclusion: The study concluded that, there is positive correlation between knee osteoarthritis (OA) and foot posture index. The abnormal foot posture was commonly seen in patients with OA Knee grade 3 and 4.

Keywords: Knee osteoarthritis, medial compartment, foot posture index

1. Introduction

Ageing is an important part of all human being reflecting the biological changes that occur, but also reflecting cultural and societal conventions. Physiological changes occur with aging in all organ systems and are frequently seen due to decline in bone mass after certain age [1]. Aging is associated with a loss in muscle strength also usually reduces muscle capacity in the core muscles of the body causing a reduction in functional abilities [1].

Osteoarthritis (OA) is an age-related disorder and is often described as a chronic degenerative disease. In OA, degradation and loss of the articular cartilage is a central feature that attributes to the "wear and tear" of the joint [2]. However, unlike an automobile tire that wears thin overtime, the tissues affected by OA contain living cells that respond to mechanical stimulation and function to maintain joint homeostasis [2, 3].

For the relationship between ageing and OA is that, ageing of musculoskeletal system increases the susceptibility to OA but alone doesn't cause it. Changes outside the joint (including sarcopenia and reduced proprioception) and within the joint (including cell and matrix changes in joint tissues) contribute to development of OA [4].

OA is the most common joint disorder in the world and is most common sources of pain and disability in elderly. Prevalence rates is estimated that 9.6% of men and 18% of women aged ≥ 60 years have symptomatic OA worldwide whereas in India it is 22% to 39% [5]. OA has been associated with poorer physical functions levels compared with both, Non- Musculoskeletal and Musculoskeletal diseases. It has been linked other health related variables such as pain, disability including work-related disability, health care usage, obesity, depression and NSAIDs use, cardiovascular disease, renal disease and diabetes are also associated with OA [6].

The human foot is anatomically a complex articular structure that's consists of 34 synovial joints of which 18 have curved surface and 16 plane surfaces [7]. The human foot consists of different innervations which enables to control the visceral functions and fright-fight-flight response in an event of injury [7]. The fact that has been exploited about the foot indicates that alterations in foot structure and function are interdependent on the body's structure and function [7].

Morphologically the human foot has arches (Medial Longitudinal, Lateral Longitudinal, Anterior Transverse and Posterior Transverse arches) which produce foot shape that is inherent and indicative for every individual [9]. The shape of the human foot in both static and dynamic should possess qualities of adaptability during weight bearing, which includes standing, walking, running, jumping and sports activity [9].

Patho-anatomically, foot commonly has congenital abnormalities which could lead to alterations in the shape and structure of the foot [8]. Other reasons involved of the foot shape includes, dysfunctional venous pump mechanism which further manifests as pedal edema due to high interstitial fluid pressure [8].

The biomechanics of the foot consists of distinct functional units with the mobile functional unit being navicular to first metatarsal and rigid functional unit being navicular and cuboid [8]. Kinetic evaluations of different foot types showed

the differences in pressure distribution beneath the foot, both static and dynamic, for presumably efficient foot function [8].

The distribution of loads transferred to the medial and lateral compartments during walking can be estimated by the external knee adduction movement (KAM); a higher external KAM indicates greater loads in the medial than in the lateral compartment [10]. The first peak KAM during walking has been shown to be a strong predictor of the presence, severity and rate of progression of the medial compartment knee OA [11]. Although the evidence for the contribution of KAM to the development of knee OA is inconsistent, several studies have shown increased KAM to be associated with knee OA severity and varus misalignment. The KAM is influenced by the variation in lower limb alignment and the motion during gait. Varus limb alignment, which is commonly observed in people with medial compartment OA, has been shown to increase and progression in knee OA. Recent studies have also reported that the people with medial compartment knee OA have been observed to have a relatively pronated foot posture and then demonstrate foot kinematic patterns that are indicative of a less mobile, everted foot type compared to the controls. Whereas, the degree of varus alignment may also affect the foot motion during ambulating which may lead to a compensatory response to allow the typical function of the foot during ambulation [12].

Knee varus and valgus deformities overload the medial and lateral knee compartment. Assessing the compensatory changes in foot posture among different grades of knee osteoarthritis may help understanding the role of foot orthoses and foot wear modification on alignment and function of the lower limb [18]. Osteophytes are so common as a radiographic feature of osteoarthritis (OA) that they have been used to define the presence of disease and grading of disease. Osteophytes most often appear at the margins of the joints, originally as outgrowths of cartilage and subsequently undergo endochondral ossification, which will also help in grading of the disease [19].

Foot Posture has been suggested to be related to the development of lower limb musculoskeletal conditions because of it's potential influence on the mechanical alignment and dynamic function of the lower limb [12]. Recent studies have reported differences in foot characteristics between people with medial compartment OA in knee and asymptomatic controls, indicating a more pronated foot posture in those with OA [13].

Foot Posture might change the mechanical alignment, and dynamic function and the development of musculoskeletal conditions of the lower limb. Foot orthosis, Knee braces, and footwear are non-operative for OA in reducing the knee adduction movement and the loading on the medial compartment as well [14].

Foot Posture Index (FPI) scale is a diagnostic clinical tool aimed at quantifying the degree to which a foot can be considered to be pronated, supinated or neutral position accordingly interpretation can be done [15]. It is a simple method of scoring various features of foot posture into a single quantifiable result, which gives an indication of the overall foot posture [15].

All observations are made with the subject standing in a relaxed angle and base gait, double limb support, static stance position [15]. The FPI rates weight bearing posture according to a series of predefined criteria. The FPI was an eight- item draft version, which through a thorough validation process was modified to a six-item version [15].

Materials and methods

Source of Data: The source of data was be elderly individuals referred to Community Physiotherapy in Dr. APJ Abdul Kalam College of Physiotherapy, Loni.

Method of collection of data

Type of Data: Primary data conducted by Principal Investigator.
Study Design: Observational Study
Sample size: 100 participants
Participants: Participants coming on basis of OPD in Community Physiotherapy Department.
Sampling Method: Convenient Sampling
Study Duration: 3 months

Materials to be used

Consent form
Data collection sheet
Recording sheet
Pen
Pencil

Procedure

All the participants referred in Community Physiotherapy department were screened according to inclusion and exclusion criteria. The participants were explained about the type of study benefits and hazards. Then informed written consent was obtained from the subjects regarding the procedure prior to the study.

The participants were first assessed by the principal investigator and the grade of knee (OA) was noted through radiological findings. The grades of OA were checked according to the Kellgren and Lawrence system for classification of knee osteoarthritis. This classification was proposed by Kellgren *et al*. in 1957 and accepted by WHO in 1961.

The classification was as follows

Grade: no radiographic features of OA present
Grade 1: doubtful joint space narrowing (JSN) and possible osteophytic lipping.
Grade 2: Definite osteophytes and possible JSN on anteroposterior weight-bearing radiograph.
Grade 3: multiple osteophytes, definite JSN, sclerosis and possible bony deformity.
Grade 4: large osteophytes, marked JSN, severe sclerosis and definite bony deformity.

They were then evaluated for foot posture with the help of Foot Posture Index scale. Foot Posture Index (FPI-6) rates weight bearing foot posture (in bilateral stance) according to series of clinical observational criteria as follows:

1. Talar head palpation.
2. Supra and infra lateral malleolar curvature.
3. Calcaneal frontal plane position.
4. Prominence in region of the Talo-navicular joint.
5. Congruence of medial longitudinal arch.
6. Abduction/adduction of forefoot on the rearfoot.

Each of the above criteria will be scored, ranging from -2 to +2 based on predetermined reference values. Finally scores of all 6 criteria will be added, which will yield to final score

for foot posture.
Interpretation: Based on final score foot posture will be classified as follows:
0 to +5----Normal
0 to -12----Pesplanus (supinated)
+6 to +12----Pescavus (pronated

Foot Posture Assessment

1. Talar head palpation: The head of the talus is palpated on medial and lateral side of the anterior aspect of the ankle

Table 1

Score	-2	-1	0	1	2
	Talar head palpale on lateral side / but not on medial side.	Talar head palpable on lateral side/ slightly palpable on medial side.	Talar head equally palpable on lateral and medial side.	Talar head slightly palpable on lateral side/palpable on medial side.	Talar head not palpable on lateral side/ but palpable on medial side.

2. Supra and infra lateral malleollar curvature: In the neutral foot it has been suggested that the curves should be equal. In the pronated foot the curves below malleolus will be more acute than the curve above due to the abduction of the foot, and eversion of the calcaneus. The opposite is true in the supinated foot.

Table 2

Score	-2	-1	0	1	2
	Curve below the malleolus either straight or convex.	Curve below the malleolus concave, but flatter/ more shallow than the curve above malleolus.	Both infra and supra malleolar curves roughly equal.	Curve below malleolus more concave than curve above malleolus.	Curve below malleolus markedly more concave than curve above malleolus.

3. Calcaneal frontal plane position: The patient standing in the relaxed stance position, the posterior aspect of the calcaneus is visualized with the observer in line with the long axis of the foot. Angular measurements are not required, the foot is graded according to visual appraisal.

Table 3

Score	-2	-1	0	1	2
	More than an estimated 5^0 inverted (varus)	Between vertical and an estimated 5^0 inverted (varus)	Vertical	Between vertical and an estimated 5^0 everted(valgus)	More than an estimated 5^0 everted (valgus)

4. Bulging in the region of the talonavicular joint (TNJ): In the neutral foot the area of skin immediately superficial to the TNJ will be flat. Bulging is associated with a pronating foot.In supinated foot the area may be indented.

Table 4

Score	-2	-1	0	1	2
	Area of TNJ markedly concave	Area of TNJ slightly, but definitely concave.	Area of TNJ flat	Area of TNJ bulging slightly	Area of TNJ bulging markedly

5. Height and congruence of the medial longitudinal arch: In a neutral foot the curvature of the arch should be uniform. In supinated foot the curve of the MLA becomes more acute at the posterior end of the arch. In the excessively pronated foot the MLA becomes flattened in the centre.

Table 5

Score	-2	-1	0	1	2
	Arch height and acutely angled towards the posterior end of the medial arch.	Arch moderately high and slightly acute posteriorly.	Arch height normal and concentrically curved	Arch lowered with some flattening in the central portion.	Arch very low with severe flattening in the central portion arch making ground contact.

6. Abduction/ adduction of the forefoot on the rearfoot: When viewed from directly, the neutral foot will allow the observer to see the forefoot equally on medial and lateral sides. In supinated foot the forefoot will adduct on the rearfoot resulting more of the forefoot being visible on the medial side. Conversely pronation of the foot causes the forefoot to abduct resulting in more of the forefoot being visible on the lateral side.

Table 6

Score	-2	-1	0	1	2
	No lateral toes visible. Medial toes clearly visible.	Medial toes clearly more visible than lateral	Medial and lateral toes equally visible	Lateral toes clearly more visible than medial	No medial toes visible. Lateral toes clearly visible

Result

In total 100 participants were evaluated from which 50% of participants were males and 50% were females. The average age of participants was 60 years.
In total 65% participants had pronated foot, 7% participants had highly pronated foot, 7% participants had supinated

foot, 5% participants had highly supinated foot whereas 16% participants had normal foot posture.

The Age wise distribution of male and female had 13% male and 21% female under age group of 60-65 years, 13% male and 16% female under age group of 66-69, whereas 24% male and 13% female under 70 and above.

The Karl Pearson correlation co-efficient(r) for the above study is 0.43, R squared value is 0.18 and the two tailed p value is <0.0001 thus the result shows extreme significance.

Discussion

Study was conducted to assess and correlate foot posture in OA detected patients using FPI scale.

Result showed that 72% had highly pronated and pronated foot posture, 12% had highly supinated and supinated foot posture and 16% had normal foot posture.

Hence according to our study 72% of the population had pronated foot posture as indicated by FPI. Similar findings were reported by Reilly and colleagues for people with severe medial knee compartment OA using several foot measures including FPI and their study concluded that pronated foot posture is common in medial knee compartment OA. Also similar study was condected by Dadia Sadbhawal, Singh Sonia and their study concluded that grade 3 and 4 exhibits a pronated or highly pronated foot, while near normal foot was observed in grade 1 and 2.

As the common malalignment seen in OA Knee is genu Varum, which may lead to compensatory foot pronation to enable the foot to be plantigrade when weight bearing [16]. Increased foot pronation could potentially reduce the knee adduction moment by shifting the centre of pressure laterally to the knee, so it is possible that the foot adapts to reduce the load on the medial compartment. However the degree of genu varum that can be compensated by foot pronation depends on the available range of motion of the ankle, subtalar, and midtarsal joints [17]. The findings reported here may have implications for orthotic and footwear interventions, in particular laterally wedge insoles have been proposed for people with OA and pronated feet, so this may reduce the knee adduction moment and other symptoms.

Data Analysis and Interpretation

Table 7: Age wise distribution of male, female percentage.

Age	Male %	Female %
60-65	13	21
66-69	13	16
70 and above	24	13

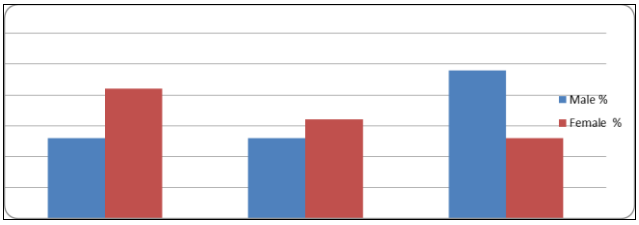

Fig 1

Result

Female population is more between age group 60-65 and male population is more between age group 70 and above

Table 8: Percentage wise classification of foot posture.

Foot Posture	Percentage (%)
Highly pronated and pronated	72%
Highly supinated and supinated	12%
Normal	16%

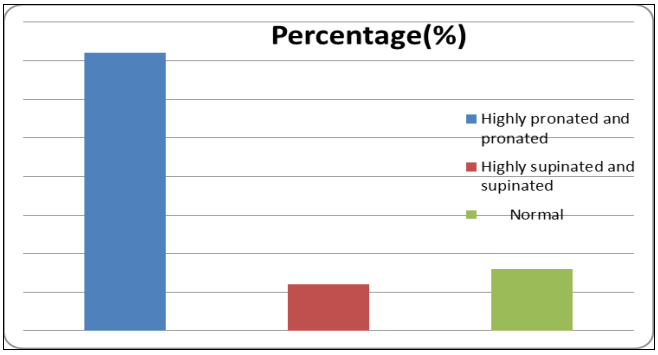

Fig 2

Table 9: showing Mean, SD, p value, r value

	FPI Score	Knee OA (Grade)
Mean±SD	5.75±4.08	2.36±0.78
p value	<0.0001	
Correlation coefficient(r)	0.43	
Result	Extremely significant	

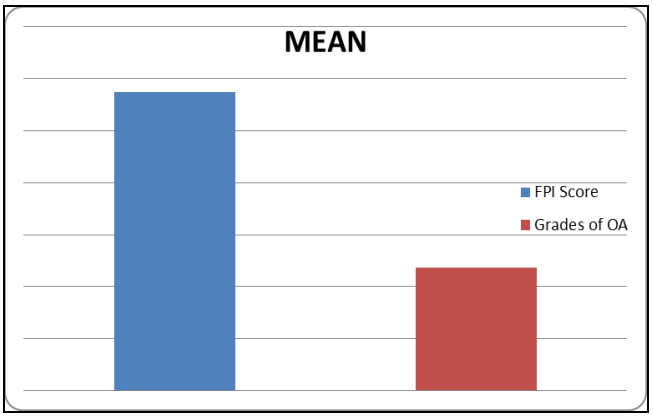

Fig 3

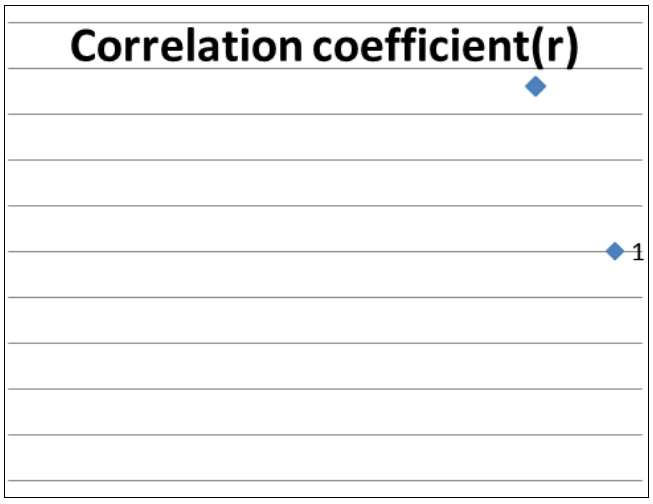

Fig 4

Table 10: Percentage wise distribution of degree of pronated foot.

Foot Posture	Percentage
Pronated foot	63
Highly pronated foot	7

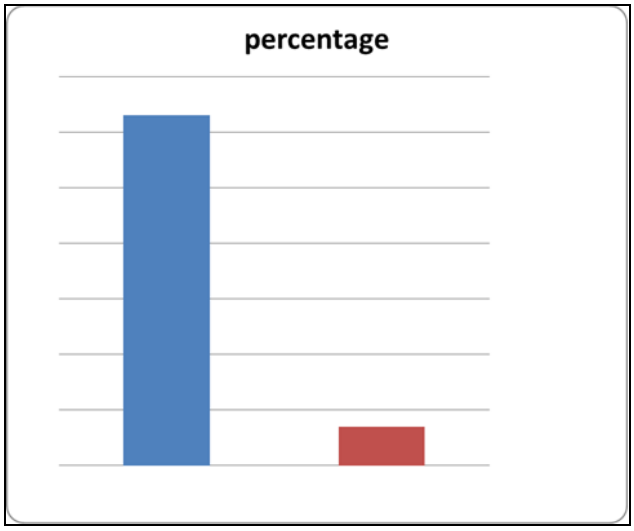

Fig 5

Result

Table shows that pronated foot posture is common as compared to highly pronated foot posture

Table 11: Percentage wise distribution of degree of Supinated foot.

Foot posture	Percentage
Supinated	7
Highly supinated	5

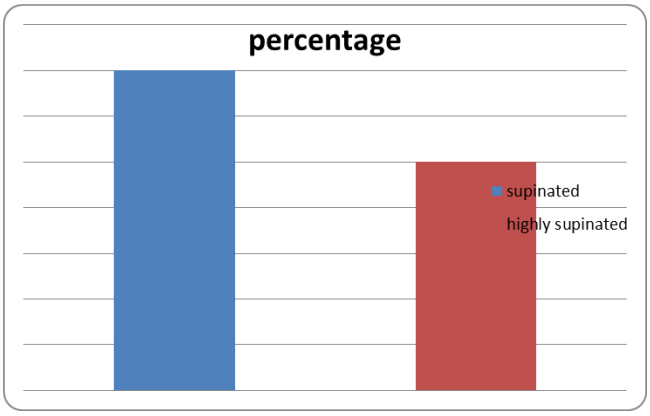

Fig 6

Result

Table shows that supinated foot is more common than highly supinated foot.

Conclusion

From the above study the conclusion could be drawn is that, the pronated foot posture is commonly seen in patients with OA Knee of Pravara Rural hospital in 72% of males and females. And there is positive correlation between knee osteoarthritis (OA) and foot posture index.

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