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Gender difference in foot progression angle in patients with osteoarthritis knee: an observational cross-sectional study

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ABSTRACT

Background: An essential clinical parameter related to gait is foot progression angle (FPA). The objective of this study was to evaluate foot progression angle difference between Kl grade 2 and 3 in osteoarthritis knee patients and understanding biomechanical factors associated knee OA.
Methods: Study was conducted on 108 patients diagnose with osteoarthritis knee according to EULAR classification knee OA. Age, gender and BMI were recorded, gait analysis was done to evaluate difference in FPA between OA knee patients with KL grade 2 and 3.
Results: The 108 patient, 68 female and 40 males with osteoarthritis knee were included in study. Mean age of patients was 55.92±0.8 year, mean BMI was 27.24±0.4 kg/m^2. Mean and SD of FPA in male 7.31±3.60 and in female 8.31± 4.18 in patients with Kl grade 2 and 3 mean difference between male and female FPA is -0.99 with 95% CI, p=0.43 and t=0.78. In KL grade 3, FPA mean and SD of male 6.79±2.80 and female 7.62±9.10, t=0.9, mean difference -0.83 with 95% CI and p=0.6925.
Conclusions: This study suggests, females in comparison to males have less FPA and therefore, females are more prone in progression of knee OA. Potential confounders including age, gender, BMI disease severity did not alter magnitude, although 95% CI.

Keywords: Osteoarthritis, FPA, Gait

INTRODUCTION

Knee osteoarthritis (OA) is a degenerative joint disease that affects the knee joint, causing pain, stiffness, and reduced mobility. It is most commonly present in the medial tibiofemoral compartment, which is the inner part of the knee joint. Walking with a greater FPA, which is the angle formed by the long axis of the foot (mid-heel to second toe) and the straight-forward line of progression of the body, has been shown to potentially reduce the knee adduction moment, a factor that is strongly associated with medial knee load and a predictor of medial OA progression.[1]

A change to particular gait-related kinematic or kinetic features could, in theory, reduce medial stress from a biomechanical perspective. The identification of traits among those having a biomechanical basis that are linked to a reduced risk of knee OA progression over time is necessary for the development of novel, and potentially disease-modifying, rehabilitative therapies.[2]

Objectives

Objectives were to evaluate FPA difference between KL grade 2 and 3 in osteoarthritis knee patients and understanding biomechanical factors associated knee OA.

METHODS

Study design

This cross-sectional timebound study was carried out from July 2021 to December 2022 in OPD of department of orthopedics AIIMS, Rishikesh.

Patient selection

Data on age, weight, height, gender, education, occupation, and comorbidities were gathered using a structured questionnaire form. Total 108 patients both Men and women aged 45 to 70 years with osteoarthritis knee, unilateral or bilateral, with grade 2 or 3 on the Kellgren Lawrence scale (KL). Knee OA group classification was developed using functional testing, radiographic findings assessed using the KL criteria (0 normal, 1 possible osteophytic, 2 definite osteophytes and possible joint space narrowing, 3 moderate and/or multiple osteophytes, definite J and possible bony attrition, 4 large osteophytes, sub-chondral sclerosis and definite bony attrition).[1] With pain score of 1, 2 or 3 intensity as per the WOMAC having, Karnofsky performance score between 80-90% were included in study as per inclusion criteria. Exclusion criteria were: Any assisted device needed for ambulation. Patients using prescribed footwear modification and any intra-articular injection within last 3 months.

Replacement of any lower extremity joint and the formation of a bilateral lateral long axis of the foot by joining the centers of the two lateral long axes were additional exclusion criteria for the current investigation.

Data collection and evaluation

The 108 patients underwent gait analysis in GAIT LAB BTS (Smart-DX 6000). Gait analysis was performed under 12 LED infra-red internet protocol base cameras, 4 video cameras, 10 force plates (8 analogue and 2 digital). Helen Hayes protocol provided with BTS smart-clinic software was used for gait analysis. After anthropometric measurement 18 surface markers will be placed on the patient according to Helen Hayes protocol. Patients were told to walk at a self-determined speed down a 5-m walkway. At least three walking trials with consistent speed and proper force plate contact were taken after three to five getting acquainted trials in order to obtain data for subsequent investigation.

Foot vector (from the second metatarsal to the posterior middle calcaneus) and the lab coordinate that corresponds to the line of progression were used to calculate the FPA.

Data processing

The kinematic, kinetic and FPA data were processed through custom software BTS (Smart-DX 6000) Digital low pass filters (Recursive fourth order Butterworth) with frequency cut-offs of 8 and 60 Hz were applied to the kinematic and kinetic signals, respectively. An inverse dynamics model that incorporates GRF and moment data, kinematic positional data specified using the protocols outlined in Grood and Suntay, and limb anthropometrics and inertial characteristics was used to determine the net external knee adduction moment.[2-4] The knee adduction moment waveform was displayed as a normalised net external moment (N m/kg) with 101 data points, or one full gait cycle (0-100%), indicating the time-normalized knee adduction moment waveform. The foot vector (from the second metatarsal to the posterior middle calcaneus) and the lab coordinate that corresponds to line of progression were used to calculate the FPA. An inaccuracy of less than 1° was discovered when this technique was evaluated against known angles marked on walkway force platform.

Analysis

The greatest value between 30 and 60% of the gait cycle was determined for each subject to represent the knee adduction moment's maximal magnitude in N m/kg during late stance.

The path of the centre of pressure on the plantar surface of the foot-where the GRF vector is thought to act during gait-was identified using force plate data. The long axis of the foot was formed by connecting the centre of pressure at heel strike and the centre of pressure at toe-off. The angle formed by the long axis of the foot and the direction of forward motion was used to determine the toe-out angle for each leg.

Ethical approval and patient consent

Informed consent was obtained from each participant included in this study. Ethical approval was taken from institutional ethics committee AIIMS, Rishikesh as this study is a part of thesis, so no separate ethical approval required and the purpose of the study was explained to each participant prior to interview and all the patients accepted to participate in the study.

Statistical analysis

Age and body mass index (BMI) followed the normal distribution, while rest of the variables did not follow normal distribution. Descriptive statistics included frequency tables, Mean and standard deviation was used for normally distributed data, and median and interquartile range was utilized for non-normally distributed data. T test was used to compare means between two groups in normally distributed data p values smaller than or equal to 0.05 were considered significant. Statistical calculations were performed with SPSS version 21 software package.

RESULT

Total of 108 patient in which 68 female and 40 males with osteoarthritis knee were included in the study. Table 1 explains, mean age of the patients was 55.92±0.8 year, mean BMI was 27.24±0.4 kg/m^2. Table 1 illustrates that mean and SD of foot progression in male is 7.31±3.60 and in female is 8.31±4.18 in patients with Kl grade 2 and mean difference between male and female FPA is -0.99 with 95% CI including p=0.43 and t=0.78. While in Kl grade 3 FPA mean and SD of male is 6.79±2.80 and in female 7.62±9.10 including t=0.9, mean difference=-0.83 with 95% CI and p=0.6925.

Table 1: Demographic characteristics including Kl grade of the patients.

Parameters	Value	Percentage
Age (in years) (mean±SD)	50.50±0.68	45-59
	66.5±6.63	59-60
BMI (kg/m^2) (mean±SD)	27.24±0.4	45-60
Gender		
Female	75	38
Male	33	17
Education		
Female	44	40
Male	23	21
KL scale		
Grade II	39	36
Grade III	62	57

Table 2: FPA difference in OA knee K/L grade between genders.

K/L grade	Male (mean±SD)	Female (mean±SD)	t value	Mean difference	P value
II	7.31±3.60	8.31±4.18	0.78	-0.99	0.43
III	6.79±2.80	7.62±9.10	0.39	-0.83	0.69
Total	17.4±10.9	14.9±14.4	0.87	2.5	0.38

DISCUSSION

It is important to identify which characteristics are associated with a decreased risk of knee OA development over time in order to create alternative rehabilitative therapies with the ability to alter the progression of the disease. Decreasing the load on the medial compartment of the knee joint may be made possible by the development of therapies that particularly address the biomechanical factors associated with the development of knee OA. The greatest value between 30 and 60% of the gait cycle was determined for each participant to represent the knee adduction moment's maximal magnitude in N m/kg during late stance.

To define group categorization, a radiographic and clinical/functional patient selection criterion were applied. According to Brandt et al radiographs by themselves are insufficient to assess the severity of knee OA pathology.[5] Clinical symptomology and radiographic characteristics are combined in current diagnostic criteria, but functional activities have not been examined.[6] Two OA groups being easily distinguished from one another based on function rather than just KL grade. The considerable decrease in walking speed for the severe group when compared to grade 2 and 3 groups helped to support this functional difference. Walking speed is correlated with function, and individuals with knee OA often have lower walking speeds than asymptomatic controls. Age, gender and BMI did not explain significant levels of variance in the characteristics of the FPA.

Within the confines of the study's constraints, the results must be interpreted. First off, as with all cross-sectional designs, it is impossible to directly extend our results to the role FPA plays in disease progression. A longitudinal design would allow for a more accurate evaluation of this. Furthermore, we did not examine the kinetic consequences of intentionally altering the FPA on the complete lower limb, which limits our ability to infer a causal connection between the FPA and the knee adduction moment. This entity has to be evaluated and its application in clinical management established. Thirdly, as was already noted, the discrete variable analysis was not designed to pinpoint the second peak in particular, but rather to capture the maximal knee adduction moment during late stance.

Limitations

Since the majority of the patients were unable to recall their symptoms in the past, it is crucial to take recall bias into account. Additionally, because it was a cross-sectional study, we were unable to evaluate the causal relationship between the factors and the limited sample size.

CONCLUSION

The patient with osteoarthritis knee had less FPA measured during quantitative gait analysis. In this study it was found that females in comparison to males have less FPA and therefore, females are more prone in progression of knee OA. Adjusting for potential confounders including age, gender, BMI disease severity did not alter the magnitude, although the 95% CI. Therefore, developing effective interventions to target these factors, may be able to slow down or even prevent the development and progression of knee OA, improving the quality of life for individuals affected by this debilitating condition.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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