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Original Research Article

Comparison of temporal-spatial gait parameter in patients with osteoarthritis knee: an observational cross-sectional study

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ABSTRACT

Background: Osteoarthritis knee (OA) symptoms, including pain, joint stiffness, reduced joint movement, and muscle strength, can affect gait kinetics, kinematics, and temporal-spatial characteristics. Spatial-temporal gait parameters are useful for assessing and identifying clinically significant changes in an individual's gait patterns and helps in rehabilitation.
Methods: In this study 108 patients diagnosed with osteoarthritis knee according to EULAR classification knee OA were included in study. Age, gender and BMI were recorded for pain and function WOMAC Score was used, gait analysis was done to evaluate difference in temporo-spatial gait parameters between OA knee patients with KL grade 2 and 3.
Results: A total of 108 patients with osteoarthritis knee were enrolled, including 40 men and 68 women. Total mean age was 55.92±9.05 years with P-value <0.05, and their average BMI was 27.24 kg/m^2. Total WOMAC score mean 29.3±1.03. Mean WOMAC scores for pain 4.57±3.26, stiffness 2.60±0.12, function score 22.20±7.55 respectively. There was no significance difference between KL grade II and III including gender in temporal spatial gait parameters.
Conclusions: This study suggests there is no significant difference in temporal-spatial gait parameters between Kl grade 2 and 3. Potential confounders including age, gender, BMI disease severity did not alter magnitude, although 95% CI.

Keywords: Gait analysis, Osteoarthritis, Temporal-spatial parameter, WOMAC

INTRODUCTION

Osteoarthritis (OA) is a degenerative condition that mostly affects weight-bearing joints like the knee. It is characterized by the progressive degradation of joint cartilage.[1]

Changes in the kinetics, kinematics, and temporal-spatial aspects of gait might result from the clinical signs of osteoarthritis (OA), which include pain, stiffness in the joints, reduced mobility in the joints, and weakness in the muscles.[2-5]

Many researchers have undertaken in-depth analyses of changes in kinetic and kinematic values in participants with knee OA; however, only a small number of parameters were used to assess changes in temporospatial parameters. Huang et al found no variations in step length, cadence, or velocity between the knee OA and healthy groups in their investigation of people with the condition.

The majority of OA patients have had significant changes in their activities of daily living (ADL), and 25% of them have some kind of functional impairment, such as morning stiffness, decreased joint motion, crepitus, and muscle atrophy.[6] In a number of earlier studies, it was discovered that the severity of OA knee significantly correlated with functional status, and knee pain was considered an independent predictor of impairment.[7-10] The functional state was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score. Each patient had an in-person interview to complete the questionnaire. The WOMAC is a self-administered health status assessment that assesses function, stiffness, and pain (either separately or all together).

The WOMAC has 24 items that are grouped into 3 subscales: pain (5 items): while walking, climbing stairs, resting in bed, sitting, or standing. Two instances of stiffness: right after waking up and later in the day. Physical Function (17 items): using stairs, getting up from a chair, standing, bending, walking, shopping, putting on/removing socks, rising from a lying position, bathing, sitting, using the toilet, heavy and light house work. Each item the patient answers generates a score that is then added up to provide an aggregated score for each dimension and a total score (WOMAC index) that represents overall disability.[11] Decreases in gait stabilization and insufficiency of everyday activities may be correlated with changes in temporospatial characteristics over the duration of knee OA.[12] Objective of this study was to compare temporal-spatial gait parameters between Kl grade 2 and 3 in osteoarthritis knee patients.

METHODS

Study design

This cross-sectional study was carried out between March 2022 to April 2023 in OPD of Department of Orthopedics AIIMS, Rishikesh.

Patient selection

A standardized questionnaire form was used to collect information on the following topics: age, height, weight, gender, education, occupation, and comorbidities. A total of 108 patients, both male and female, between the ages of 45 and 70, had unilateral or bilateral osteoarthritis of the knee, rated as Grade 2 or 3 on the Kellgren Lawrence scale.

The Kellgrene-Lawrence (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, subchondral sclerosis and definite bony attrition) and pain score of 1, 2, or 3 intensities as per the WOMAC were used to develop the knee OA group classification.[12-17]

Inclusion criteria

Karnofsky performance score between 80-90% were included in the study.

Exclusion criteria

Any assisted device needed for ambulation, patients using prescribed footwear modification and any intra-articular injection within the last 3 months were excluded.

Data collection and evaluation

Today 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.

Data processing

The kinematic, and kinetic data were analyzed using specialized BTS software (Smart-DX 6000). The kinematic and kinetic inputs were subjected to digital low pass filters (Recursive fourth order Butterworth) with frequency cut-offs of 8 and 60 Hz, correspondingly.

The net external knee adduction moment was calculated using an inverse dynamics model that takes consideration of limb anthropometrics and inertial characteristics, kinematic positional data specified using the techniques explained by Grood and Suntay, and GRF and moment data.[8]

The knee adduction moment waveform was shown as a time-normalized normalized net external moment (N m/kg) that includes 101 data points, or one complete gait cycle (0-100%).[18]

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 center of pressure on the plantar surface of the foot-where the Ground Reaction Force (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 center of pressure at heel strike and the center of pressure at toe-off.

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. For data that was normally distributed, the mean and standard deviation were used; for data that was not normally distributed, the median and interquartile range were used.

All spatial-temporal gait parameters and self-evaluation questionnaire scores were presented as mean (SD), followed by 95% confidence interval. Data were analyzed with IBM SPSS software version 19.0, and the significance level was set at 0.05.

RESULTS

Total of 108 patients in which 68 females and 40 males with osteoarthritis knee were included in the study. In Table 1, total mean age of the patients was 55.92±0.8 year with p value<0.05, which was significant and total mean BMI was 27.24±0.4 kg/m^2 with P value 0.20 which was not significant while considering education its p value was 0.15 and whereas Kl grade II and III with p value 0.86 was not significant. In Table 2, total mean and SD of WOMAC was 29.37±1.03 and p value was 0.092 which was not significant. On comparison of spatiotemporal gait parameter between Kl grade II and III and both the genders in Table 3 having t value 0.46 and p value 0.64 of stride length, step length t value 1.11 and p value 0.26, step width t value 0.75 and p value 0.45, walking velocity t value 1.02 and p value 0.3, cadence t value 0.73 p value 0.46 was found non-significant.

Table 1: Detail table of demographics including Kl grade.

	Male (n= 75), Mean and SD	Female (n=33), Mean and SD	P value
Age	61.60±8.9	52.77±7.43	<0.05
BMI	26.5±4.2	27.68±4.56	0.20
Education	**N**	**N**	
Illiterate	8	15	0.151
Up to high school	10	5	
Above high school	7	9	
Kellgren-Lawrence scale; no. (%)			
Grade II	10	29	0.869
Grade III	15	47	

Table 2: WOMAC score of male and female.

WOMAC score	Male	Female	Mean±SD	P value
Pain	171	312	4.57±3.26	0.092
Stiffness	90	185	2.60±0.12	
Function	717	163	22.20±7.55	
Total	978	660	29.37±1.03	

In Table 4, on comparing spatial-temporal gait parameter between male and female in Kl grade II was also found not significant while stride length, t value 0.46 p value 0.64, step length t value 1.11 and p value 0.26, step width t value 0.75 and p value 0.45, walking velocity t value 1.02 and p value 0.3, cadence t value 0.73 and p value 0.46 whereas, in Table 5 spatial-temporal gait parameter difference between male and female in Kl grade III it shows II stride length, t value 0.34 and p value 0.75, step length t value 1.16 and p value 0.25, step width t value 0.86 and p value 0.39, walking velocity t value 1.03 and p value 0.3, cadence t value 0.64 and p value 0.52. There was no significant difference found between both the genders and spatial-temporal gait parameters and including WOMAC and KL grades. In the study only age factor was significant with p value<0.05.

Table 3: Spatial-temporal gait parameter difference between Kl grade II and III.

Grade	STL	SL	SW	WV	C
II	1.85±0.26	0.90±0.18	0.11±0.05	3.06±11.16	95.35±12.08
III	1.88±0.35	0.95±0.24	1.53±11.70	1.38±5.09	97.37±14.26
t-value	0.46	1.11	0.75	1.02	0.73
p-value	0.64	0.26	0.45	0.3	0.46

Table 4: Spatial-temporal gait parameter difference between male and female in Kl grade II.

Grade II	STL	SL	SW	WV	C
Male	1.87±0.30	0.86±0.25	0.10±0.02	5.04±16.19	93.84±14.92

Continued.

Grade II	STL	SL	SW	WV	C
Female	1.84±0.24	0.91±0.15	0.11±0.06	2.2±8.26	96.0±1.8
T value	0.31	0.62	0.75	0.72	0.78
P value	0.75	0.53	0.45	0.47	0.43

Table 5: Spatial-temporal gait parameter difference between male and female in Kl grade III.

Grade III	STL	SL	SW	WV	C
Male	1.89±0.30	0.98±0.24	0.10±0.04	1.65±6.05	98.15±14.52
Female	1.85±0.41	0.90±0.23	4.95±21.57	0.75±0.20	95.49±13.78
T value	0.34	1.16	0.86	1.03	0.64
P value	0.72	0.25	0.39	0.3	0.52

DISCUSSION

This study reported non- significant results in temporal-spatial parameters and WOMAC including KL Grade of subjects with KOA and in the study only age was found to be significant on comparison. This finding indicates that, in spite of biomechanical alterations such the varus deformity commonly observed in knee OA. Patients with knee OA demonstrate pathological gait patterns. Specifically, patients with knee OA demonstrate a deterioration in spatial-temporal gait parameters including slower walking velocity, shorter step length and shorter single-limb support (SLS) compared to matched controls. Recent studies have reported an association between the level of symptoms (i.e. pain and functional limitation) of knee OA patients and their gait pattern.[19] The evaluation of variations in gait will be useful in anticipating the appearance of compensatory mechanisms throughout time.[20] The impact of knee osteoarthritis on a patient's gait has been examined by quantitative measurement of several gait parameters, including step length, step breadth, stride length, walking velocity, and cadence. Researchers use quantitative gait analysis extensively.[21] Limited data is available to compare spatial -temporal (walking velocities, cadences, step widths, and stride length) in patients with osteoarthritis.[22] Numerous investigations have demonstrated a relationship between moments in the knee and hip as well as in the sagittal plane and declining velocity degrees of flexion and find out significant correlation between healthy individuals and KOA patients but not found significance difference between KL grade, gender and spatial-temporal gait parameters.[23,24]

This study has few limitations. Recall bias must be taken into consideration because most patients were unable to recall their symptoms in the past. We were also unable to assess the causal relationship between the covariates and the small sample size because the study was cross-sectional.

CONCLUSION

In conclusion, alterations in spatiotemporal gait characteristics in OA knee patients seem to be related to the progression of the condition. Early detection of gait abnormalities associated with OA knee may be useful in differentiating between anomalies that contribute to the disease's progression and those that arise as a part of the compensatory mechanism as the disease progresses. It is recommended that rehabilitation techniques be focused on interventions that successfully address gait impairment. Additionally, future research should include an objective gait analysis to monitor and assess the impact of different treatments in comparison to matched controls.

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