Three-Dimensional Gait Analysis in Moderate Knee Osteoarthritis: A Cross-Sectional Study of Spatiotemporal and Kinematic Alterations

Dr. Isabel George A
All India Institute of Medical Sciences (AIIMS), Raipur, Chhattisgarh, India

Dr. Mrithunjay Rathore
All India Institute of Medical Sciences (AIIMS), Raipur, Chhattisgarh, India

Dr. Amol Khade
All India Institute of Medical Sciences (AIIMS), Raipur, Chhattisgarh, India

Dr. Bikram Keshari Kar
All India Institute of Medical Sciences (AIIMS), Raipur, Chhattisgarh, India

Abstract

Background: Knee osteoarthritis is a chronic degenerative joint disorder associated with pain, reduced mobility, impaired function, and altered gait mechanics. While gait abnormalities are well recognized in advanced stages of knee osteoarthritis, biomechanical changes during moderate stages require greater attention, as this phase provides an important window for early rehabilitation and functional intervention. Three-dimensional gait analysis helps to identify compensatory mechanisms that may not be evident during routine clinical examination.

Objectives: The present study aimed to evaluate gait alterations in patients with moderate knee osteoarthritis using a 3D motion gait analyser. The main objectives were to assess spatiotemporal gait parameters and to identify compensatory gait mechanisms adopted by patients.

Methods: A cross-sectional observational study was conducted among 25 patients with bilateral knee osteoarthritis, radiologically confirmed as Kellgren Lawrence Grade II and III. Participants were recruited from Orthopedics and Physical Medicine and Rehabilitation outpatient departments after screening according to inclusion and exclusion criteria. Institutional Ethics Committee approval was obtained, and informed consent was taken from all participants. Gait analysis was performed using force plates and a 3D motion capture system. The recorded data were processed and analyzed using BTS and the biomechanics laboratory software. The obtained gait parameters were compared with standard reference values.

Results: The study demonstrated marked alterations in spatiotemporal and kinematic gait parameters among moderate knee osteoarthritis patients. Mean walking velocity was substantially reduced compared with normal reference values (0.444 ± 0.187 m/s versus 1.20 ± 0.20 m/s). Cadence was also reduced (80.02±14.44 steps/min versus 114 ± 4.2 steps/min). The stance phase was increased bilaterally, with values of 68.80% on the right side and 67.77% on the left side, compared with the normal value of approximately 59%. The swing phase was reduced bilaterally, with values of 31.63% on the right side and 31.33% on the left side, compared with normal value of 40%. The Gait Profile Score was elevated bilaterally above normal values in all patients, indicating kinematic impairment, with mean scores of 13.41±11.44 on the right side and 11.36 ± 2.88 on the left side. All parameters demonstrated highly statistically significant deviation from normality ($p < 0.001$), confirming clinically meaningful gait impairment in moderate knee osteoarthritis patients.

Conclusion: This study demonstrates that moderate knee osteoarthritis is associated with significant alterations in gait mechanics. Reduced gait velocity, cadence, stride length, and swing phase, along with increased stance phase, double support time, and step width, which reflects a compensatory mechanism adopted to reduce pain and enhance stability. These findings emphasize the clinical value of 3D gait assessment in identifying functional impairment and planning rehabilitation strategies. Targeted interventions such as muscle strengthening, balance training, and gait retraining may help improve mobility, reduce functional decline, and facilitate better long-term outcomes in moderate knee osteoarthritis patients.

Keywords

Knee osteoarthritis, 3D gait analysis, spatiotemporal parameters, biomechanics, Kellgren - Lawrence grading.