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Editorial

Is motion the best medicine? Rethinking knee osteoarthritis through gait analysis

Aavrati Rastogi, Roop B. Kalia*, Pradeep K. Meena

Department of Orthopaedics, AIIMS, Rishikesh, Uttarakhand, India

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***Correspondence:**
Dr. Roop B. Kalia,
E-mail: roop.orth@aiimsrishikesh.edu.in

A gradual degenerative joint disease, knee osteoarthritis (OA), places an enormous strain on healthcare systems around the world, especially in older people and those with metabolic and biomechanical risk factors. Knee OA causes crippling pain, stiffness, and functional incapacity.[1] It is characterized by the slow deterioration of articular cartilage, subchondral bone sclerosis, osteophyte formation, and persistent synovial inflammation. Because of its intricate pathophysiology and the interaction between systemic inflammation and biomechanical stressors, the disease continues to pose a significant challenge, even with the availability of pharmacologic medicines, intra-articular therapy, and surgical procedures.[1,2]

While patient-reported indices like the Western Ontario and McMaster universities osteoarthritis index (WOMAC) and radiographic grading using the Kellgren-Lawrence system are essential for assessing OA, they provide a limited view of the biomechanical perturbations that sustain disease progression.[3] Gait analysis is becoming vital because it offers objective, quantitative assessments that clarify pathological variations in movement mechanics and highlight abnormal loading patterns that hasten articular deterioration and functional loss.[4,5] Gait analysis can potentially improve diagnostic precision, and guide focused treatment approaches in the management of osteoarthritis by bridging the gap between structural pathology and dynamic joint dynamics.[6,7]

Advanced gait analysis has identified significant biomechanical abnormalities in knee OA patients.[8] These abnormalities include increased dynamic varus thrust, decreased knee flexion during the stance phase, increased external knee adduction moment (EKAM), and changed foot progression angles.[9,10]Asymmetric joint loading, increasing cartilage degeneration, and increased pain perception are all caused by these abnormal movement patterns. In addition to being pain-reduction mechanisms, these biomechanical abnormalities actively prolong the course of the disease by causing undesirable joint kinematics that hasten tissue deterioration and subchondral bone remodeling.[11]

The identification of gender-specific biomechanical adaptations is an essential aspect of gait analysis. Due to factors such as increased valgus alignment, altered neuromuscular control, and more significant quadriceps activation deficits, epidemiological studies have shown that women had a higher prevalence and severity of knee OA. These variations highlight the need for precision medicine techniques that consider the biomechanical variety and call for a gender-specific approach to OA rehabilitation.[12] Additionally, differences in neuromuscular activation and proprioceptive feedback between men and women imply that tailored rehabilitation regimens may improve treatment outcomes and reduce disease course.[13]

Recent developments in wearable sensor technologies and gait analysis have entirely transformed the monitoring and treatment of OA. Real-time evaluation of gait characteristics is made possible by inertial measurement units (IMUs), plantar pressure sensors, and smartphone-based motion-tracking apps. This allows for the early detection of biomechanical anomalies before irreparable joint damage occurs. A paradigm change towards proactive disease management is represented by

incorporating these technologies into clinical practice, where early biomechanical intervention can reduce pathological joint loads and the requirement for surgical interventions.[14]

A multidisciplinary strategy that connects biomechanics, genetic biomarkers, and advanced imaging modalities is key to managing knee OA in the future. More precise patient categorization, more individualized treatment planning, and improved long-term functional results are all made possible by integrating gait analysis into routine clinical examination. To reduce excessive joint stress and maximize movement efficiency, biomechanical corrective techniques such as neuromuscular retraining, orthotic interventions, kinetic chain optimization, and proprioceptive training have enormous potential.

The transition from a symptomatic therapy concept to a mechanical approach that emphasizes the biomechanical underpinnings of joint health will be essential as our understanding of knee OA expands. We can improve treatment paradigms, preserve mobility, and improve the quality of life for millions of people afflicted by OA by using gait analysis as a foundational tool for evaluation and intervention.

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