International Journal of Research in Orthopaedics
Rastogi A et al. Int J Res Orthop. 2024 Nov;10(6):1329-1333
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20243131

Protocol

Effectiveness of gait analysis in management of osteoarthritis knee at primary care settings in Asia: a systematic review and meta-analysis protocol

Aavrati Rastogi[1], Roop B. Kalia[1]*, Rajkumar Yadav[2], Osama Neyaz[2]

[1]Department of Orthopedics, AIIMS, Rishikesh, Uttarakhand, India
[2]Department of Physical Medicine and Rehabilitation, AIIMS, Rishikesh, Uttarakhand, India

Received: 10 August 2024
Revised: 11 September 2024
Accepted: 17 September 2024

***Correspondence:**
Dr. Roop B. Kalia,
E-mail: roopkalia2003@yahoo.com

ABSTRACT

Background: This systematic review will focus on the effectiveness of gait analysis on osteoarthritis knee management. The objectives of this systematic review and meta-analysis are to synthesize the clinical effectiveness and to compare the effectiveness of gait analysis in the osteoarthritis knee management in Asian population.
Methods: This review will be conducted and reported according to PRISMA guidelines. To discover relevant papers, the search technique will use MeSH terms such as osteoarthritis knee, gait analysis, osteoarthritis knee management, primary healthcare, effectiveness, and Asia. Other synonymous words will be searched using the Boolean operator "and"/"or" on PubMed, Embase, Scopus, and Cochrane. Randomized controlled trials assessing the efficacy of gait analysis in the therapy of osteoarthritis knee patients in primary care settings in Asia will be considered. A random effects meta-analysis will be carried out using the REVMAN software version 5.3.5. The STATA software version SE16 will be used for both cumulative and comparative meta-analysis.
Conclusions: This review and meta-analysis will be among the first to give an extensive purview on the effectiveness of gait analysis in osteoarthritis knee management at primary care settings in Asian population. This study will also acknowledge the effects of different gait analysis strategies with an attempt to compare the same.
Trial Registration: The protocol has been registered at the International Prospective Register of Systematic Reviews (PROSPERO registration number: CRD42024540444).

Keywords: Osteoarthritis knee, Gait analysis, Primary health care, Asia

INTRODUCTION

The knee is the most often affected load-bearing joint, with disease affecting the medial compartment more than any other. The lack of an effective treatment is a significant contributor to the burden of knee osteoarthritis (KOA). Currently, treatment options include medication and therapy for reducing symptoms, followed by arthroplasty when the joint is seriously damaged. As a result, there is an urgent need to develop therapy alternatives, which requires a better understanding of OA pathogenesis. KOA is a joint condition characterized by intricate interactions between biomechanical, structural, and biochemical mechanisms at the in vivo system level.[1]

KOA is a pathology that is mainly characterized by pain during common activities as stairs climbing, chair rising, or bending activities; other signs and symptoms are a limited range of motion, pain at maximal extension and flexion range, and knee joint usually hold in antalgic position; stiffness, usually in the morning, and possible malalignment in advanced conditions are also present.[2]

Physical examination is fundamental to suspect KOA, while radiographic findings are the gold standard for the instrumental diagnosis when clinical suspicion of KOA is raised.[3] One of the essential parts of a clinical examination is the analysis of gait and its deviations.[4] The observational analysis is the most used method in clinical practice, although it is useful to point out that its intra- and interobserver reliability is limited.[5] Trying to overcome these limitations, many studies have been published investigating KOA subjects' deviations with different instruments and devices; among them the commonest are optoelectronic systems and inertial measurement units.[6]

Non-invasive gait data on knee osteoarthritis were collected in a gait laboratory equipped with a camera-based motion capture system and force plates embedded in the floor.[7] The process involves sticking reflective markers to the subject using sticky tape. A calibration technique is then used to create a subject-specific anatomical model based on the locations of markers put on anatomical landmarks and anthropometric measurements. The individual then goes through a series of walking trials across the laboratory. Marker trajectories are processed using the anatomical model to establish the position and orientation of the pelvic, thigh, shank, and foot anatomical frames, as well as the hip, knee, and ankle joints, during the trials. The anatomical alignment of the thigh and shank determines the knee angles (flexion/extension, adduction/abduction, and internal/external rotation). In addition to the kinematic description, an inverse dynamic technique is frequently used to determine knee kinetics.[8]

The result of this analysis produces three moments that correspond to the external forces operating on the joint (muscle forces are not included in this calculation), which are to flex/extend, adduct/abduct, and internally/early stance. Mid-stance, terminal stance swing combining the findings of previous research identifying certain occupations and sports as risk factors for KOA with the findings indicating that the intensity of physical activity is not associated with the risk of OA development in the general population, suggests the need for gait analysis to better understand the mechanical pathway leading to knee OA. While an overall description of the ambulatory function using spatiotemporal measures is sufficient to analyze several disorders, such data are not detailed enough to detect the small biomechanical changes involved in KOA.[9] As a result, gait evaluations in the context of knee OA mainly focused on three-dimensional kinetic and kinematic patterns. Speed and other spatio-temporal gait parameters are essential results used to describe gait in a number of diseases. KOA is not an exception, with multiple studies showing reduced walking speed in OA patients compared to non-OA individuals, as well as a slower gait speed in severe OA patients compared to moderate OA knee patients.[10] While these basic metrics are useful in describing general ambulatory performance, they are insufficient to reveal small changes in knee biomechanics. It is thus vital to investigate the three-dimensional kinetic and kinematic patterns of the knee. The most common approach for measuring these patterns is based on non-invasive motion capture equipment, which is typically a combination of cameras and force plates. Interventional approaches, such as instrumented prosthesis or medical imaging, are also used since they allow for direct measurement of tibiofemoral interactions.[11,12] When selecting a gait study method, it's important to consider other factors such as a testing environment that doesn't disrupt patients' natural walking patterns, large cohorts that compensate for interpatient variability, and minimal interference from external sensors. While internal measures may be more precise, it's still an alternative between both methods. These factors have generally resulted in the use of noninvasive movement analysis. Today, the noninvasive method is well-established, and there is compelling evidence that it provides a sufficiently correct description of knee biomechanics for the investigation of OA. This computation generates three moments that correspond to the external pressures operating on the joint (muscle forces are not included), namely the flex/extend, adduct/abduct, and internally/externally rotated knee. Moments are typically reported in normalized values (i.e., as a proportion of body weight and height, %BW×height), allowing for comparison between individuals. Finally, the amplitudes of characteristic peaks on the kinetic and kinematic time-curves are quantified and utilized to compare individuals' ambulatory knee biomechanics. Although most gait data related to knee OA were gathered using the method described above, actual collection and post-processing protocols vary by institution, and these changes can influence the results. Other variables, such as participant characteristics (age, BMI, or illness location, for example), or the statistical technique, may also influence the findings and limit comparisons among gait studies. Walking speed is also an important consideration when understanding knee biomechanics since it determines the amplitude of numerous gait variables. Mills et al conducted a systematic review to provide the first reference dataset on lower-limb biomechanics in knee osteoarthritis.[13]

Gait analysis scores

Schwartz and Rozumalski introduced the gait deviation index (GDI) to quantify deviation from physiological gait, followed by the gait profile score (GPS) in 2009. This was a significant innovation in the field of gait analysis.[14] These scores can be used as outcome measures for gait deviation. Studies from such a perspective are now being published. Kobsar et al employed the GDI to compare healthy and KOA participants.[15] KOA patients scored 85 to 91, while healthy people scored 92 to 100. While Naili et al evaluated the scores of the two limbs in participants with unilateral KOA, they found no differences but a substantial reduction in GDI when compared to healthy controls.[16,17]

To effectively manage KOA, patients must self-monitor their adherence to prescribed regimens and make lifestyle changes like as nutrition, exercise, and weight

management. KOA patients without professional training or knowledge may experience difficulties due to poor self-management. Primary health care, including gait analysis, is the most efficient, equitable, and cost-effective way to serve the population. Primary health care offers health services, prevention education, and disease management to persons in the community.

Gait analysis is critical for understanding the effects of ambulatory biomechanics on OA progression and developing appropriate treatment strategies. Multidisciplinary research is required to connect biomechanical alterations with structural and molecular elements of OA. In Asia, there has been less research on the efficacy of gait analysis for controlling KOA. This study investigates the efficacy of gait analysis in OA knee treatments for controlling KOA in Asian populations.

METHODS

The protocol will follow PRISMA recommendations.[4] The protocol has been registered in International Prospective Register of Systematic Reviews (PROSPERO Registration number- CRD42024540444s). This systematic review and meta-analysis aims to synthesize the clinical effectiveness of gait analysis in managing KOA patients in primary care settings in Asia, as well as compare the effectiveness of various gait intervention strategies.

Data sources search terms and search strategy

The search approach will use MeSH terms such as osteoarthritis knee, gait analysis, knee osteoarthritis management, primary healthcare, effectiveness, and Asia to identify relevant papers. To search for synonyms, use the Boolean operator "AND"/"OR". We will run systematic searches using all feasible combinations of MeSH phrases.

An electronic database search will be conducted using PubMed, Embase, Scopus, and Cochrane. The included studies will be cross-referenced to identify additional relevant papers, which will then be searched through Google Scholar.

Searches will be limited by language, not historical time limits. Following the literature search, records will be collected into EndNote X9 for deduplication. After removing duplicates, any remaining references will be saved in an excel file. Two reviewers will individually scan the records based on titles and abstracts, selecting qualifying research.

Inclusion criteria

Type of study design used

Randomized controlled trials examining the effectiveness of gait analysis in the management of KOA patients will be eligible for inclusion.

Study population

Study population will include the published articles in which the participants were patients diagnosed with OA grade II, grade III and grade IV.

Intervention

This systematic review will cover published studies in which the intervention was implemented following gait analysis in KOA patients.

The literature evidence of moderate to high quality on the alteration of spatiotemporal parameters of gait: one of the most affected and clearly altered parameters in knee KOA is gait speed, as subjects walk at a slower self-selected speed compared with healthy subjects.

This review will identify that speed affected the gait patterns of different populations with respect to the amplitude of spatiotemporal parameters, joint kinematics, joint kinetics, and ground reaction forces.

Comparator

We will review studies that use the comparator as the typical care for managing KOA patients.

Outcomes

We will include RCTs with outcomes such as mean change in HbA1c, CRPH, RBS, quality of life, and psychological distress.

Publication time span

We will examine RCTs conducted between 2014 till 2023 on the effectiveness of gait analysis in managing KOA patients.

Study setting

RCTs which include the primary health care settings will be reviewed.

Language of the published literature

This review will be limited to articles published in peer-reviewed journals in English.

Exclusion criteria

Studies not following the aforementioned study design, studies where OA knee sufferers were not the primary participants, studies on any surgical intervention on hip and ankle, and patients in treatment for life-threatening illnesses, with cognitive or mobility impairments, or requiring nursing care were eliminated.

Assessment of the risk of bias

The selected studies will be assessed for bias using the Cochrane collaboration's methodology. The tool examines selection, performance, detection, attrition, and reporting biases. Studies will be rated as 'low risk of bias', 'high risk of bias', or 'unknown bias' to indicate their bias risk.[17]

Meta-analysis

Cochran's Q will be used to evaluate heterogeneity. This test assumes that all studies from the same osteoarthritic population measure the same thing will also be utilized to assess heterogeneity.[18] The Cochrane collaboration's Review manager (version 5.3.5) will be used to synthesize data. The forest plot will use weighted mean difference with 95% confidence intervals as the predefined outcome measure.

DISCUSSION

This research and meta-analysis is the first to provide a comprehensive overview of gait analysis effectiveness in knee osteoarthritis management in primary care settings in Asia. This study aims to compare the effectiveness of various Gait analysis tactics. Disease advancement was linked to increased heel-strike KFA, as well as mid-stance KAM and KFM. This suggests an amplification process in which the disease might cause specific gait changes, which can also contribute to disease development. This amplification mechanism is consistent with the progression of OA.[19] The mid-stance KFM was observed differently, as patients appeared to diminish this kinetic parameter, which contradicted the connection between mid-stance KFM and OA progression. The difference between the three parameters could be attributed to the correlation between mid-stance KFM and pain, as well as the possibility of walking with lower mid-stance KFM. Although OA-related variations may be protective, the sagittal plane kinetic parameter is still of major relevance.[20]

Therefore, we need to further understand, study, and master the law of occurrence and development of KOA, which is very important for the prevention and treatment of KOA. With the gradual advancement in gait analysis technology, great progress has also been made in the field of orthopedics. Gait analysis could clearly record the full process of the examiner's activities, capturing the activity status and storing it permanently. Traditional evaluation procedures need the patient to stand still or make specified actions in order to obtain measurements. Gait analysis may complete the inspection as a person walks in its most natural form, resulting in the inspection procedure being automatic and naturalized.

In contrast to traditional visual observation and physical measurement, gait analysis results are supplied in the form of data to enable quantitative and objective gait function evaluation.[21,22]

CONCLUSION

Patients with medial knee OA show significant differences in knee adduction moment, flexion moment, and flexion angle when walking compared to non-OA people. Furthermore, kinetic and kinematic gait factors have been linked to OA progression. Gait study is essential for understanding the impact of ambulatory biomechanics on OA progression and designing effective treatment approaches. Multidisciplinary research is needed to link biomechanical changes to the structural and biochemical aspects of OA.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Andriacchi TP, Favre J, Erhart-Hledik JC, Chu CR. A systems analysis of knee osteoarthritis reveals new insights into the pathogenesis of the disease. Ann Biomed Eng. 2015;43:376-87.
2. Andriacchi TP, Favre J. The nature of in vivo mechanical signals that influence cartilage health and progression to knee osteoarthritis. Curr Rheumatol Rep. 2014;16:463.
3. Coggon D, Croft P, Kellingray S, Barrett D, McLaren M, Cooper C. Occupational physical activities and osteoarthritis of the knee. Arthritis Rheum. 2000;43(7):1443-9.
4. Kujala UM, Kettunen J, Paananen H, et al. Knee osteoarthritis in former runners, soccer players, weight lifters, and shooters. Arthritis Rheum. 1995;38:539-46.
5. Felson DT, Niu J, Yang T, Torner J, Lewis CE, Aliabadi P, et al; MOST and OAI investigators. Physical activity, alignment and knee osteoarthritis: data from MOST and the OAI. Osteoarthritis Cartilage. 2013;21(6):789-95.
6. Barbour KE, Hootman JM, Helmick CG, Murphy LB, Theis KA, Schwartz TA, et al. Meeting physical activity guidelines and the risk of incident knee osteoarthritis: a population-based prospective cohort study. Arthritis Care Res (Hoboken). 2014;66(1):139-46.
7. Astephen JL, Deluzio KJ, Caldwell GE, Dunbar MJ. Biomechanical changes at the hip, knee, and ankle joints during gait are associated with knee osteoarthritis severity. J Orthop Res. 2008;26(3):332-41.
8. Mills K, Hunt MA, Ferber R. Biomechanical deviations during level walking associated with knee osteoarthritis: a systematic review and meta-analysis. Arthritis Care Res (Hoboken). 2013;65:1643-65.
9. Cappozzo A, Della Croce U, Leardini A, Chiari L. Human movement analysis using stereophotogrammetry. Part 1: theoretical background. Gait Posture. 2005;21:186-96.

10. Andriacchi TP, Johnson TS, Hurwitz DE, Natarajan RN. Musculoskeletal dynamics, locomotion, and clinical applications. In: Mow VC, Huiskes R, editor. Basic orthopaedicbiomechanics and mechano-biology. Third edition. Philadephia: Lippincott Williams & Wilkins; 2005.
11. Walter JP, D'Lima DD, Colwell CW Jr, Fregly BJ. Decreased knee adduction moment does not guarantee decreased medial contact force during gait. J Orthop Res. 2010;28:1348-54.
12. DeFrate LE, Sun H, Gill TJ, Rubash HE, Li G. In vivo tibiofemoral contact analysis using 3D MRI-based knee models. J Biomech. 2004;37:1499-504.
13. Baker R, McGinley JL, Schwartz MH, Beynon S, Rozumalski A, Graham HK, et al. The gait profile score and movement analysis profile. Gait Posture. 2009;30(3):265-9.
14. Schwartz MH, Rozumalski A. The Gait Deviation Index: a new comprehensive index of gait pathology. Gait Posture. 2008;28(3):351-7.
15. Kobsar D, Charlton JM, Hunt MA. Individuals with knee osteo¬arthritis present increased gait pattern deviations as measured by a knee-specific Gait Deviation Index. Gait Posture. 2019;72:82-8.
16. Naili JE, Esbjörnsson AC, Iversen MD, Schwartz MH, Hedström M, Häger CK, et al. The impact of symptomatic knee osteoarthritis on overall gait pattern deviations and its association with performance-based measures and patient-reported outcomes. Knee. 2017;24(3):536-46.
17. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al; Cochrane Bias Methods Group; Cochrane Statistical Methods Group. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011;343:d5928.
18. Baker R, Esquenazi A, Benedetti MG, Desloovere K. Gait analysis: clinical facts. Eur J Phys Rehab Med. 2016;52(4):560-74.
19. Klöpfer-Krämer I, Brand A, Wackerle H, Müßig J, Kröger I, Augat P. Gait analysis–Available platforms for outcome assessment. Injury. 2020;51:S90-6.
20. Lakes EH, Allen KD. Gait analysis methods for rodent models of arthritic disorders: reviews and recommendations. Osteoarthritis and cartilage. 2016;24(11):1837-49.
21. Baker R, Esquenazi A, Benedetti MG, Desloovere K. Gait analysis: clinical facts. Eur J Phys Rehab Med. 2016;52(4):560-74.
22. Klöpfer-Krämer I, Brand A, Wackerle H, Müßig J, Kröger I, Augat P. Gait analysis–Available platforms for outcome assessment. Injury. 2020;51:S90-6.

Cite this article as: Rastogi A, Kalia RB, Yadav R, Neyaz O. Effectiveness of gait analysis in management of osteoarthritis knee at primary care settings in Asia: a systematic review and meta-analysis protocol. Int J Res Orthop 2024;10:1329-33.