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الجمعية السعودية لجراحة العظام
Saudi Orthopedic Association

Journal of Musculoskeletal Surgery and Research

Article in Press

Letter to Editor

Reevaluating root: Challenges and limitations in modern biomechanical practice

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Received: 12 July 2024
Accepted: 04 August 2024
Epub ahead of print: 30 August 2024
Published:

DOI
10.25259/JMSR_262_2024

Quick Response Code:

Dear Editor,

With this letter, I would like to raise some critical considerations regarding applying the root biomechanical model in podiatric clinical practice. While recognizing the significant contribution of root to understanding foot biomechanics, I believe that it is necessary to discuss its limitations and practical implications, especially in light of the latest scientific knowledge and technological advancements such as three-dimensional (3D) motion analysis and pedobarography.[1,2]

The root model was developed in the 1970s and is based on a series of static criteria to assess the alignment and function of the foot. One of the main aspects of the model is the identification of neutral positions and structural deviations from these ideal positions.[1,3] However, one of the major limitations of the root model is that it focuses primarily on static assessments, which do not adequately consider the dynamics of load and gait. Biomechanical assessment under load, which considers the forces and moments acting on the foot during movement, is fundamental for accurately understanding biomechanical functions and dysfunctions.[4]

The lack of dynamic assessment is a serious shortcoming, as many foot and ankle problems manifest during motion. The foot is a dynamic structure that changes configuration and functionality depending on the different phases of the gait cycle. Therefore, a static assessment cannot provide a complete picture of the biomechanical conditions of the foot. Recent studies have shown that the forces applied to the foot during gait significantly alter the position and alignment of its bony and articular structures. Ignoring these aspects can lead to inaccurate diagnoses and, consequently, ineffective or inappropriate treatments.[5]

To move beyond the limitations of the root model, modern biomechanical assessments incorporate advanced technologies such as 3D motion analysis and pedobarography. These tools provide more precise and dynamic assessments of foot function. For instance, 3D motion analysis allows for the comprehensive tracking of foot movements across different phases of the gait cycle, highlighting deviations and dysfunctions that static assessments might miss. Pedobarography provides detailed maps of plantar pressure distribution, offering insights into the load patterns and identifying high-pressure areas that could be prone to injury.[6]

Consider the use of 3D motion analysis in a patient with flatfoot; this advanced technology can provide detailed insights into the phases of gait where the arch collapses, allowing for more

How to cite this article: Tedeschi R. Reevaluating root: Challenges and limitations in modern biomechanical practice. J Musculoskelet Surg Res. doi: 10.25259/JMSR_262_2024

targeted and effective interventions. Pedobarography, on the other hand, can be crucial in designing custom orthotics by mapping pressure points with high precision, thereby improving patient outcomes.[7]

In addition, the criteria used in the root model exhibit considerable inter-observer variability. Reproducibility of measurements is an essential requirement for any clinical methodology, and variability between different observers reduces confidence in diagnoses based on these criteria. Studies have demonstrated that key measurements, such as identifying the neutral position of the rearfoot, can vary significantly between different operators. This aspect compromises the validity and reliability of the root model as a diagnostic tool in clinical practice.[1,8]

Another critical point concerns the insufficient attention to individual variability in foot morphology and function. Each patient presents unique characteristics that influence foot and gait biomechanics, including anatomical differences, muscle tone, joint mobility, and lifestyle. The standardized approach proposed by the root model may not be adequate to capture these individual variations, leading to a reductive and potentially misleading view of the patient's conditions. Personalization of assessment and treatment is crucial to effectively address biomechanical foot problems.

It is also concerning that the root model continues to be widely taught in universities, particularly in podiatry courses. Students are trained on a model that presents several criticalities and limitations, risking negatively influencing their future clinical practice. University education should reflect the latest scientific knowledge and promote methodologies supported by solid evidence that consider the full complexity of the human foot. The insistence on teaching the root model may lead future podiatrists to base their assessments and treatments on criteria that do not accurately reflect clinical reality.[9]

In light of these considerations, a critical rethinking of the use of the root biomechanical model in clinical practice and university teaching is necessary. It is essential to develop and adopt assessment methods that are more dynamic and personalized, considering foot behavior under load and during gait, and supported by more solid and reproducible evaluation criteria. Advanced technologies, such as 3D motion analysis and pedobarography, offer valuable tools for a more accurate and detailed assessment of foot functions under dynamic conditions. These tools allow precise analysis of the forces acting on the foot, plantar pressures, and joint dynamics during the gait cycle, providing objective data that can significantly improve the diagnosis and treatment of biomechanical dysfunctions.[1,6,10,11]

APPROPRIATE USES OF THE ROOT MODEL

While the root model has significant limitations, it can still be useful in specific contexts. For example, in initial clinical assessments where quick evaluations are needed, the static criteria of the root model provide a straightforward method to identify gross deformities and guide further investigations. In addition, in educational settings, understanding the root model can serve as a foundational step before introducing more advanced and dynamic assessment techniques.

GLOBAL USE OF THE ROOT MODEL

The root model remains extensively taught and applied in various regions, particularly where access to advanced technologies is limited. For instance, in some developing countries, its simplicity and cost-effectiveness make it a viable option for initial foot assessments. Incorporating international perspectives in the critique can highlight the model's global relevance and the necessity for accessible, updated methodologies that can be implemented worldwide.

In conclusion, I invite the scientific and academic community to critically reflect on using and teaching the root biomechanical model. It is essential to adopt a more updated and evidence-based approach that considers the complexity of foot biomechanics in motion and the individual variability of patients. Only through a paradigm shift in the assessment and treatment of foot problems can we improve the quality of clinical practice and ensure superior education for podiatry students, while also addressing the accessibility challenges faced in different regions of podiatry students.

ETHICAL APPROVAL

The Institutional Review Board approval is not required.

DECLARATION OF PATIENT CONSENT

Patient's consent was not required as there are no patients in this study.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The author confirms that no artificial intelligence (AI)-assisted technology was used to assist in the writing or editing of the manuscript, and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

FINANCIAL SUPPORT AND SPONSORSHIP

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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