

Editorial

Foot progression angle in knee osteoarthritis – a modifiable lever for medial knee load or an oversimplified therapeutic target

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Knee osteoarthritis (OA) is no longer viewed solely as a degenerative disorder, but as a mechanically driven disease in which aberrant joint loading dictates both symptom progression and structural decline. Within this framework, the foot progression angle (FPA) has emerged as a clinically accessible and modifiable biomechanical parameter that may influence medial knee joint loading.

FPA, defined as the angle between the longitudinal axis of the foot and the direction of gait progression, directly alters the orientation of the ground reaction force (GRF) vector and, consequently, the magnitude of the external knee adduction moment (KAM) - a well-established surrogate marker of medial tibiofemoral load. In individuals with medial compartment OA, increased FPA (toe-out gait) is commonly observed as a compensatory adaptation to reduce pain and redistribute joint stress.^{1,2} Mechanistically, this adjustment reduces the frontal plane lever arm of the GRF relative to the knee joint center, thereby attenuating KAM, particularly during the late stance phase.^{3,4} This positions FPA as a practical, non-invasive target for clinicians seeking to modulate joint loading through gait retraining.

Despite a strong biomechanical rationale, the clinical effectiveness of FPA modification remains contentious. While reductions in KAM are consistently reported, the translation of these changes into meaningful improvements in pain and function is variable.⁵ This disconnect raises a critical concern regarding the over-reliance on surrogate mechanical markers as proxies for clinical success. It also underscores the complexity of knee OA, where multiple factors beyond joint loading alone influence pain and function.

A key explanation for this variability lies in the heterogeneity of patient-specific biomechanics. The influence of FPA on knee loading is modulated by factors such as coronal plane alignment, disease severity, neuromuscular control, and pain sensitization.^{6,7} For example, individuals with varus malalignment may derive greater benefit from toe-out gait, whereas others may exhibit negligible or inconsistent responses. Such variability highlights the limitations of uniform gait-modification strategies and underscores the growing need for precision-based rehabilitation approaches.

Importantly, FPA alteration does not act in isolation but induces coupled changes across the kinetic chain. Modifications in foot orientation influence tibial rotation, subtalar mechanics, and proximal joint kinematics, including the hip and pelvis. Although evidence suggests that FPA adjustments may not significantly increase hip joint moments, concerns remain regarding potential compensatory loading at the patellofemoral joint and ankle.^{7,8} These considerations emphasize the necessity of adopting a system-level biomechanical perspective, rather than focusing on isolated joint parameters.

Furthermore, reliance on KAM as the primary outcome measure may oversimplify the biomechanical complexity of knee OA. KAM does not fully capture joint contact forces, shear stresses, or muscle co-contraction patterns that contribute to cartilage loading and disease progression.

Consequently, interventions aimed solely at reducing KAM may not yield consistent structural or symptomatic benefits.

Nevertheless, FPA remains an attractive therapeutic target due to its modifiability and feasibility in clinical practice. Advances in wearable sensor technology and real-time biofeedback systems offer new opportunities for individualized gait retraining, enabling clinicians to tailor interventions based on patient-specific movement patterns. Such innovations may facilitate the transition toward data-driven, personalized rehabilitation strategies.

In this context, FPA should not be considered a standalone intervention but rather a component of a comprehensive rehabilitation framework that includes muscle strengthening, neuromuscular re-education, and alignment optimization. Integrating these elements may enhance both biomechanical efficiency and clinical outcomes.

In conclusion, foot progression angle represents a compelling yet complex biomechanical lever in knee osteoarthritis. While its capacity to modulate medial knee loading is well established, its role as an isolated therapeutic target is likely oversimplified. Without individualized biomechanical profiling and integrative rehabilitation strategies, FPA modification risks remaining a mechanistically sound yet clinically inconsistent intervention. Future research should prioritize patient-specific response patterns and long-term outcomes to fully realize the potential of FPA in managing knee OA.

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