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Different walking strategies impact patella cartilage pressure in individuals with patellofemoral instability

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Background

Patellofemoral instability (PFI) is a common orthopaedic condition in adolescence. Current studies used musculoskeletal simulations to investigate the influence of different morphological factors on patellofemoral joint loading [1]. However, these studies were based on the gait pattern of one healthy individual and, therefore, neglected the impact of different compensational walking strategies on patellofemoral joint loading [2]. This study aimed to investigate the influence of varying gait patterns on patella cartilage pressure in individuals with PFI.

Methods

We included 29 individuals (34 affected knees) with PFI in the study. They were divided into two groups, considering the sagittal knee moment according to Clark et al. [2]. Individuals with no knee flexion moment in the loading response phase were allocated to the patellofemoral group 1 (PFG1, N = 12) group. Otherwise, they were assigned to the patellofemoral group 2 (PFG2, N = 22). The groups showed no significant differences in demographics, morphology and walking speed [3]. Simulations were based on gait data and a musculoskeletal model with defined knee joint cartilage surfaces [4]. Patella cartilage pressures were estimated using an elastic foundation model and the COMAK routine [5]. For statistical analysis, alpha level was set to 0.05 and the groups were compared using statistical parametric mapping.

Results

Compared to the PFG2, the PFG1 showed increased knee extension, external rotation, hip extension and decreased dorsiflexion angles in the stance phase (Figure 1a). The PFG1 showed lower peak and average cartilage pressure as well as cartilage contact area especially in the mid-stance phase compared to PFG2 (Figure 1b).

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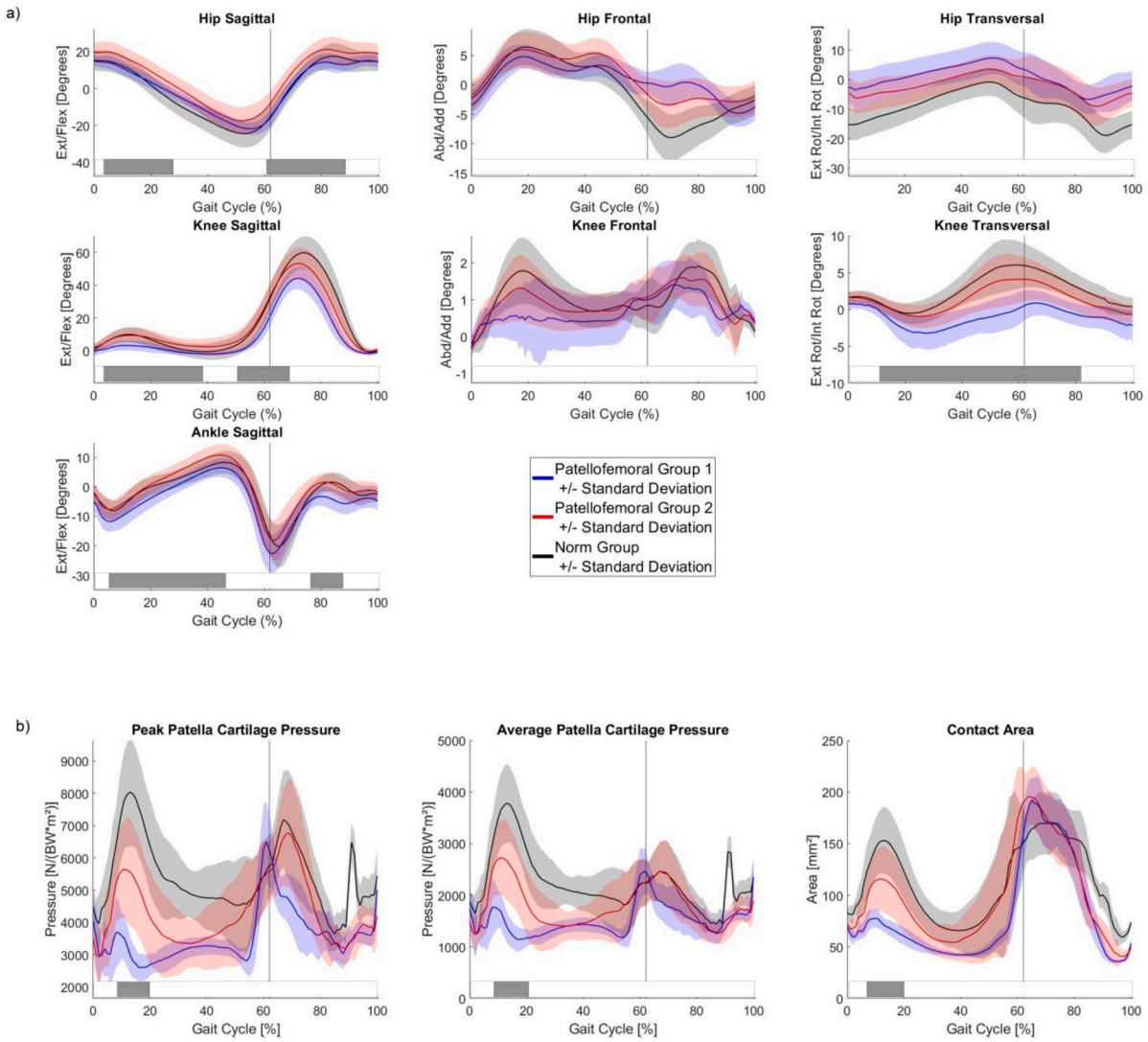

Figure 1. a) Kinematics of knee, hip and ankle joints. b) Cartilage pressure and contact area predictions. Grey bars represent significant differences ($p<0.05$).

Conclusions

This is the first study showing that individuals with PFI use different walking strategies to alter patella cartilage loading. Both groups walked with lower patella cartilage pressure compared to a typically developing group. The PFG1 walked with a more extended and externally rotated knee to achieve a higher reduction of the patella cartilage pressure. As our simulations were based on a generic knee model and did not include patient-specific morphologies, all differences of the simulations are related to the different walking strategies. Therefore, it can be concluded that it is essential to implement not only the subject-specific geometry but also the individual gait pattern for the investigation of patellar cartilage pressure in subjects with PFI.

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