Bilateral frontal plane lower limb alignment during gait is correlated across severity of knee OA but not post-TKA

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Summary

In 614 knees in 307 participants, frontal plane alignment during gait measured with markerless motion capture was correlated between left and right knees across all combinations of asymptomatic, mild-moderate, and severe knee OA. Only knees with a knee replacement on one side were uncorrelated with the alignment of the other side.

Introduction

The low burden of data collection with markerless motion capture offers the potential for larger scale data collections and in non-laboratory environments, providing whole body kinematics with no additional resource requirements, in contrast to marker-based approaches. While much gait analysis has been performed unilaterally historically, bilateral data from markerless motion capture provides increased sample sizes as well as the opportunity to consider the status of both limbs in biomechanical analyses. The objective of our analysis was to compare bilateral gait waveform data in participants with varying combinations of knee osteoarthritis (OA), post-total knee arthroplasty (TKA), and asymptomatic joints, using principal component analysis (PCA) for the knee joint angle waveforms in the frontal and sagittal planes

Methods

Orthopaedic patients were recruited directly from an assessment clinic where they had been referred for evaluation of knee OA by advanced practice physiotherapists who provided a clinical status assessment (based on x-ray, function, and pain) for both knees (as mild, moderate, or severe OA, or asymptomatic, or previous TKA). Additional asymptotic participants were recruited from the community. Gait was assessed during over-ground walking at a self-selected speed (6 lengths of a 10 m walkway). Participants wore the clothes and shoes they had worn that day. Markerless motion capture was recorded using 8 commercially available synchronized video cameras (Sony RX0-II) recorded at 60 Hz with 1/125 shutter speed and processed using Theia3D (Theia Markerless Inc., version v2023.1.0.3161p9). Data were excluded for participants wearing long skirts or dresses. Principal component analysis (PCA) was applied to the gait waveforms and principal component (PC) scores were calculated for knee joint angle waveforms in the frontal plane (knee ab-/adduction, stance only) and sagittal plane (knee flexion/extension, whole stride). Simple linear regression was applied to determine correlations of left and right knee PC scores for all combinations of knee joint statuses. Mild and moderate knee OA were collapsed into a single category ("MildMod").

Results and Discussion

614 knees in 307 individuals were included. In individuals with a TKA on one side, frontal plane PC1 (magnitude of knee abduction/adduction during stance) was not correlated with the other side, but for all other combinations of clinical status, there were statistically significant correlations, with stronger correlations for the same clinical status on both sides (Figure 1). In the sagittal plane, PC2 (associated with stiff knee gait) was significantly correlated across all groups. This is in keeping with previous research that has shown that knee flexion measures are associated with speed, supporting the within participant correlations.
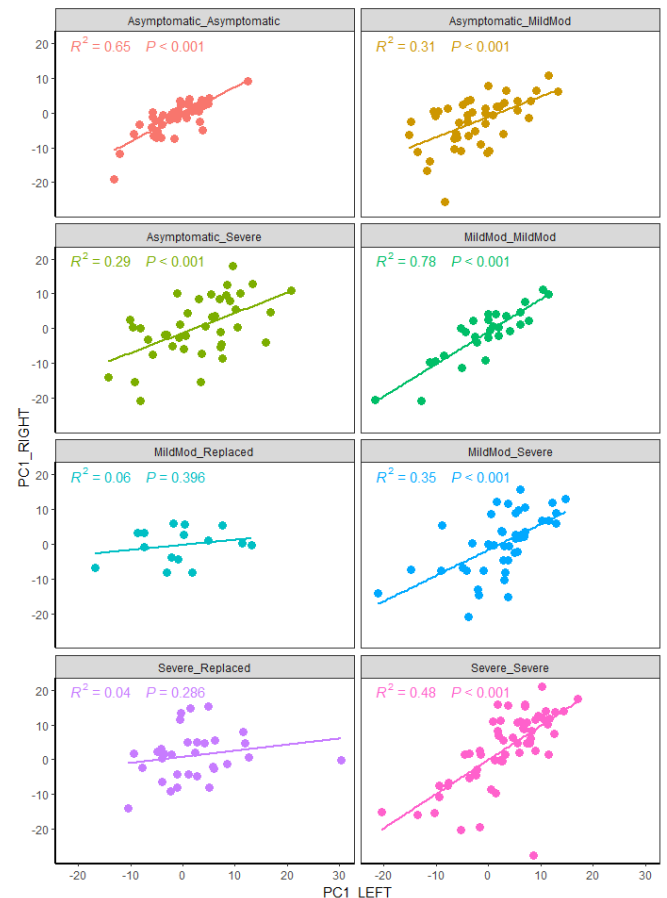

Figure 1: Correlations between frontal plane PC1 scores (magnitude of knee ab-/adduction during stance) of both legs for all combinations of clinical status. "Replaced" = post-TKA, "MildMod" = mild or moderate OA.

Conclusions

Correlations between left and right knee frontal plane alignments suggest a level of person-specific alignment that is retained across severities of knee OA.