INTRODUCTION
The demand for total knee arthroplasty (TKA) surgery is increasing dramatically, but it is expected that present human resources will be unable to meet the demand in the near future. Hence we need to develop objective models to determine who will benefit most from TKA in order to effectively manage waitlists. This study determined whether changes in pain, function and joint loading could be predicted from pre-TKA gait biomechanics and muscle activation patterns.

METHODS
57 participants (65 (7) years old, 32 (6) kg/m²) with severe medial knee OA were tested within one week prior to TKA and approximately one year (365 (54) days) later. Participants completed the WOMAC questionnaire [1] at each testing session (self-report measures of pain and function).

Three-dimensional motion of the lower limb, ground reaction forces, and electromyograms (EMG) from seven lower extremity muscles (medial and lateral gastrocnemius, vastus lateralis and medialis, rectus femoris, medial and lateral hamstrings) were recorded during walking at a self-selected speed. External joint moments were calculated using inverse dynamics and were amplitude-normalized to body mass. EMG data were amplitude-normalized to maximal voluntary contraction efforts.

Gait waveforms were time-normalized to 100% of the gait cycle then analyzed using Principal Component Analysis (PCA) [2,3]. Self-selected gait speed and knee adduction moment (KAM) magnitude (PC1) were used as objective measures of function and medial compartment loading, respectively. Pearson product-moment correlation coefficients were calculated between the PC scores and the change in i) WOMAC pain and function scores, ii) velocity, and iii) KAM PC1 scores. Correlations with p-values less than 0.10 were entered into stepwise regression analyses (α = 0.10 to enter and leave the model). A regression model was developed for the change (post-TKA – pre-TKA) in i) WOMAC pain, ii) WOMAC function, iii) walking velocity, and iv) dynamic loading (i.e. change in KAM PC1 score).

RESULTS
A phase shift in early stance activity (PC3) for the vastus medialis waveform explained 12.0% (p>0.05) and 13.7% (p<0.05) of the variance in the change post-TKA in WOMAC pain and function scores, respectively. Participants not displaying the phase shift had greater improvements in self-reported pain and function.

Prolonged stance phase activity (PC2) for the lateral hamstrings explained 23.6% of the variance in the change in gait velocity (p<0.001). Participants with prolonged hamstrings activity pre-TKA had greater improvements in gait speed post-TKA.

The pre-TKA score for the overall magnitude of the medial compartment load (KAM PC1) was the best predictor for the change in this variable post-TKA. 62.7% of the variance was explained by the pre-TKA PC1 score (p<0.001), with an additional 4.8% of the variance being explained by the overall amplitude of activity (PC1) for rectus femoris (p<0.05). Higher pre-TKA KAM and rectus femoris activation were associated with greater post-TKA decreases in the KAM overall magnitude.

DISCUSSION AND CONCLUSIONS
While pre-TKA biomechanics and muscle activation patterns were poor predictors of changes in self-reported outcome measures, they did predict greater proportions of variance in objective measures of function and loading. More altered muscle activation patterns and higher KAM magnitude pre-TKA, indicative of poorer pre-TKA gait patterns, were associated with greater improvements in gait speed and greater decreases in medial compartment loading (KAM PC1). These findings have implications for managing TKA waitlists and illustrate the difference between subjective and objective outcomes.

REFERENCES

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