INTRODUCTION
Abnormal knee function as a result of severe knee osteoarthritis (OA) has been well characterized. After total knee arthroplasty (TKA) surgery, comparisons of knee mechanics relative to the pre-operative state have been studied to assess the functional success of the surgery. Less well acknowledged are the compensatory changes in hip and ankle joint mechanics that accompany severe knee osteoarthritis [1], and whether or not TKA surgery has positive or potentially detrimental effects on the mechanics of these joints. The purpose of this study was to characterize the changes in joint angle patterns at the hip and ankle after TKA surgery.

METHODS
Three-dimensional lower extremity kinematics were captured during gait for 60 asymptomatic subjects and 64 patients within a week prior to receiving a TKA surgery and one year post-surgery (Optotrak™ motion capture). Three-dimensional hip and ankle angles were calculated according to the Joint Coordinate System [2] and the sagittal plane angles were normalized to 100% of the gait cycle. Principal component analysis (PCA) was applied to each angle (hip and ankle separately) to extract the major modes of variability in the data [3]. Paired t-tests were used to compare post-TKA angle patterns to the pre-TKA state and ANOVA was used to compare both to the asymptomatic group.

RESULTS
Post-TKA gait speed was found to be significantly faster (0.90±0.23) than pre-TKA (1.07±0.19) gait (P<0.001). The first 3 principal components for hip and ankle sagittal plane flexion angles explained 92% and 87% of the variability cumulatively, respectively. The overall magnitude of hip flexion during gait (PC1) was lower than the asymptomatic magnitude pre-TKA and remained lower post-TKA, (P=0.037), indicating that hip flexion magnitude was not restored postoperatively. The relative difference (i.e. range) between late stance hip extension and swing phase flexion (PC2) increased from pre-TKA to post-TKA (P=0.001), yet still remained lower than asymptomatic values post-TKA (P<0.001) (Figure 1).

PC2 of ankle flexion captured the plantar/dorsiflexion range of motion throughout gait. There were no changes in PC2 from pre to post-TKA, and patients exhibited less angular range compared to the asymptomatic group (P<0.001). PC3 characterized later peak plantar and peak dorsiflexion angles in the gait cycle, with significant differences between pre and post-TKA (P=0.006). Post-TKA, patients had higher PC3 scores, meaning that they had a later peak post operatively, restoring patterns closer to the asymptomatic group with no differences from asymptomatic to post-TKA (P=0.36) (Figure 2).

DISCUSSION AND CONCLUSIONS
This study showed some improvements in sagittal plane hip and ankle angle patterns one-year after-TKA surgery. However, some compensatory changes in hip and ankle mechanics that were associated with severe OA pre-TKA were maintained post-TKA. This suggests that while TKA surgery improves joint function in the lower extremity, some abnormal patterns persist that may be indicative of an unfavourable mechanical environment. To our knowledge no other studies have examined the mechanics of the hip and ankle joint after a TKA. Post-TKA outcome should therefore objectively assess entire lower extremity function, and implant/surgical design should aim to optimize entire lower extremity function.

REFERENCES