Introduction
The successful design of artificial knees is related to the dynamics imposed by the design. Recent fluoroscopic data have identified kinematic patterns associated with specific designs (Banks et al., 1997). However, these studies have been limited to kinematic data during restricted movements. Kinematic and kinetic data from standard gait laboratories offer the ability to measure knee joint dynamics during activities of daily living. However, gait studies have been limited in their ability to discriminate between gait patterns from different implant designs (Andriacchi et al., 1982). We have found that the discriminatory power of gait data can be increased with the use of principal component analysis of the gait waveform data (Deluzio et al., 1999). This study examined gait pattern differences between a rotating platform (RP) and a meniscal bearing (MB) implant design.

Methods
Acceptable candidates for either implant were randomly assigned to an implant group (RP: n=22; MB: n=17) and all testers were blinded to the grouping. Three-dimensional gait analysis was carried out before implantation and 1 year post-operatively. The gait system was used to calculate three dimensional knee joint angles, moments and forces resulting in nine gait measures represented as waveform data (Li et al., 1993). Principal component analysis was used to extract features of the gait waveform data and comparisons between the two groups of subjects were based on these features (PC scores). Principal component analysis is a multivariate statistical technique that has been used to capture shape changes in waveform data. Mathematically, principal component analysis consists of an orthogonal transformation, which converts the time-normalized waveforms into new uncorrelated principal components. These components are optimal in the sense that they explain a maximal amount of variance. The first three PCs were obtained from each of the nine gait measures and these were used to find differences between the two groups.

Results & Discussion
There were no differences between the groups prior to surgery and at post-operative testing there were no differences in gait speed, stride length or cadence. The PC analysis was able to extract features of the gait waveform data that discriminated between the gait patterns of the two types of implants. The PC analysis of the adduction moment is shown in Figure 1. The first PC corresponds to the major source of variation, which is typically the overall level of the waveform. In this case PC1 captures variability due to the level of the adduction moment during stance. The patients with the MB implant had a higher PC1 value corresponding to a higher adduction moment during stance than the RP group (p<0.04). Differences were also found in the PC1 score of the internal/external knee moment (p<0.04). Figure 2 reveals that this PC corresponded to the magnitude of the internal/external moment during stance. The MB implant group had a higher internal/external rotation moment. Both of these implants are of the mobile bearing design. The tibial component of the RP platform rotates about a fixed axis while the MB’s tibial component can rotate and translate. Changes in the kinematics and kinetics may have implications for long term implant survival.
References


Figure 1 The Adduction Moment PC1. A The adduction moment waveform data corresponding to the mean (solid line) and the 5th and 95th percentiles (dashed) of the PC1 scores. B The loading vector corresponding to PC1. This is multiplied by the waveform data to obtain the PC1 scores. This PC is a weighted average of the adduction moment during stance.

Figure 2 The Internal/External Rotation Moment PC1. A The internal/external rotation moment waveform data corresponding to the mean (solid line) and the 5th and 95th percentiles (dashed) of the PC1 scores. B The loading vector corresponding to PC1. This is multiplied by the waveform data to obtain the PC1 scores. This PC is a weighted average of the internal/external rotation moment during stance.