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Gait Analysis in Kinematic Versus Mechanical Alignment in Total Knee Joint Arthroplasty (TKA) - A Randomized Trial

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Summary:
We found no significant differences across the KA and MA procedures in relation to bilateral limb symmetry during walking ($p > 0.05$) across all variables studied. The theoretical advantage of KA technique in restoring a more natural gait was not observed in this study.

Abstract:
Introduction

Traditional mechanical alignment (MA) attempts to position femoral and tibial components perpendicular to the mechanical axis of each bone. Kinematic alignment (KA) attempts to match implant position to the prearthritic anatomy of individual patients, with the aim of restoring more normal gait kinematics for that patient and potentially improving functional outcome. The aim of this study was to compare MA and KA techniques in restoring bilateral limb symmetry during walking following unilateral TKA.

Methods

Twenty-seven patients with unilateral osteoarthritis who had been randomised to receive a MA (n=14) or KA (n=13) procedure underwent gait analysis in a biomechanics laboratory at a minimum of 24 months post operation. Eligible patients had a well-functioning native knee on the contralateral side to their TKA. In the KA group, patient-specific cutting-blocks were manufactured using individual pre-operative magnetic resonance imaging data. In the MA group, computer navigation was used to ensure neutral mechanical alignment accuracy. Subjects attended a biomechanics laboratory where a nine camera motion analysis system was used to collect 3D kinematic data of the left and right limbs as subjects performed five trials of walking at a self selected speed. During these trials, 3D ground reaction forces and moments during the stance phase were recorded with a force platform. Kinematic and kinetic data were analyzed using the Visual 3D biomechanics software program. The kinematic variables of interest were sagittal and frontal plane knee angle at footstrike, and the change in these angles in the initial loading phase following footstrike. The kinetic analysis was focused on the initial loading phase and the dependent variables were the peak moment and peak power calculated in sagittal and frontal planes. Differences in these variables across legs were calculated, and these differences were then compared across groups in the statistical analysis (independent t-tests).

Results

We observed no difference in the kinematic variables of frontal plane knee angle at footstrike (mean difference -0.12°, 95% confidence interval [CI] -4.41° to 4.17°, $p = 0.95$), sagittal plane knee angle at footstrike (mean difference -0.47°, 95% CI -4.69° to 3.75°, $p = 0.82$), frontal plane maximum flexion in loading (mean difference -0.41°, 95% CI -3.75° to 2.92°, $p = 0.80$), and sagittal plane maximum flexion in loading (mean difference 1.40°, 95% CI -2.88° to

5.67°, p = 0.51). Likewise, we observed no difference in the kinetic variables of frontal plane peak moment (Nm/kg) in initial loading (mean difference -0.22, 95% CI -0.53 to 0.08, p = 0.14), sagittal plane peak moment in initial loading (mean difference 0.03, 95% CI -0.12 to 0.18, p = 0.65), and sagittal plane power (W/kg) at the knee (mean difference -0.16, 95% CI -0.35 to 0.03, p = 0.10)

Conclusions

We found no significant differences across the KA and MA procedures in relation to bilateral limb symmetry during walking (p > 0.05) across all variables studied. The theoretical advantage of KA technique in restoring a more natural gait was not observed in this study.