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Knee Biomechanics During Ramp Walking After A Total Knee Arthroplasty With Either A Medial Pivot Or Posterior Stabilized Implant

Orthopaedics / Knee & Lower Leg / Joint Replacement - Primary

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Keywords: Biomechanics, Total Knee Arthroplasty, Medial Pivot, Posterior Stabilized, Kinematics, Kinetics,

Background
Walking up and down a ramp is a common daily activity and is more demanding on the knee joint than level walking. Knee osteoarthritic patients often have difficulty, especially while walking down a ramp. It is unknown if different implant designs would provide better knee biomechanics during a ramp ascent or descent task.

Objectives
The goal of this study was to compare knee biomechanics during a ramp ascent and descent task in patients who underwent total knee arthroplasty (TKA) with either a medial pivot (MP) or posterior stabilized (PS) implant design, compared with healthy controls (CT).

Study Design & Methods
This prospective study compared ten patients whom underwent unilateral TKA with either a MP (M=3, F=2; age=59.6±8.1 years; BMI= 28.9±3.2kg/m2) or PS (M=3, F=2; age=60.6±9.2 years; BMI=28.8±4.5kg/m2) implant with five CT (M=3, F=2; age=63.6±6.2 years; BMI=23.9±1.4kg/m2). All patients underwent biomechanical gait analysis within 1 month of surgery, and 1 year following surgery. All surgeries were done by the same surgeon using a sub-vastus approach. Knee joint biomechanics were recorded using ten infrared cameras and two portable force platforms embedded on a 3m ramp inclined at 9°. A minimum of five trials were processed and time-normalized to a complete gait cycle (GC) for each limb. Knee joint biomechanics were calculated, and included sagittal and frontal joint angles and moments, as well as joint powers. The side of interest was the operated limb for the TKR groups and the dominant limb in the CT group. Knee biomechanics were compared between groups throughout the entire gait cycle using a statistical nonparametric mapping analysis (α=0.05); paired t-test to compare the pre-/post-operative differences, and t-test to compare the different groups.

Results
No significant differences in age or BMI existed between any of the groups. No significant pre-operative differences were identified between the MP and PS groups, indicating that both groups were similar pre-operatively. During the ramp ascent task, the MP group had significantly greater post-operative knee flexion during the swing phase (67-72% GC) compared with the PS group. During the ramp ascent task, the PS group had significantly lower post-operative knee flexion compared to the CT group during the stance phase (0-34% GC) as well as throughout the swing phase (65-97% GC). The MP group had no significant post-operative differences in sagittal knee joint angles compared with the CT group for the ramp ascent and descent tasks. During the ramp descent task, both the PS and MP groups had significantly lower knee joint power compared to the CT group during the during the stance phase (MP:23-26%; PS: 23-29% GC).

Conclusions

The MP group patients demonstrated similar sagittal knee motion as healthy controls during both the ramp ascent and descent tasks. The PS group had significant post-operative differences in sagittal knee kinematics compared to both the MP and CT group during stance phase, and to the CT group during swing phase. However, both implants had significant knee power differences compared to the CT group during the ramp descent task. This occurred throughout mid-stance for both groups, during the transition from double-limb to single-limb support. This may be indicative of weakness in the knee extensor muscles, as both groups have lower concentric knee power compared to the CT group. This study had limitations, primarily the small sample size. Future studies should also include muscle activity measurements recorded with electromyography to determine if one implant provided better neuromuscular adaptations.