Lunging after knee replacement surgeries

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Introduction

A Bi-compartmental Knee Replacement (BKR) is a potential solution for patients who have isolated osteoarthritis in the medial/lateral and patellofemoral coampartments. It is reported that 28% of TKR candidates could be considered for a BKR.[1] The main benefits of a BKR are the preservation of both cruciate ligaments and bone stock, minimized operative trauma and quicker recovery for patients.[2] The iDuo system is a customized BKR whose implants are designed to fit each patient. To this date there have been no in-vivo studies looking into the biomechanics of patients with a BKR when performing various activities. The goal of this study was to examine the differences in knee mechanics between patients with a BKR, TKR and healthy controls.

Methods

In-vivo kinematics for 23 subjects were assessed in this study. 7 patients who had received a TKR (Persona, Zimmer Inc., Warsaw, IN) and 4 patients who had received a BKR (iDuo, ConforMIS Inc, Bedford, MA) were compared to a control group of 12 patients. Laboratory testing was performed a minimum of 6 months post-operatively. High speed video cameras were used to capture 3D kinematic and kinetic data as patients performed common daily activities (level walking and sit to stand) and exercises (fast walking and lunges).

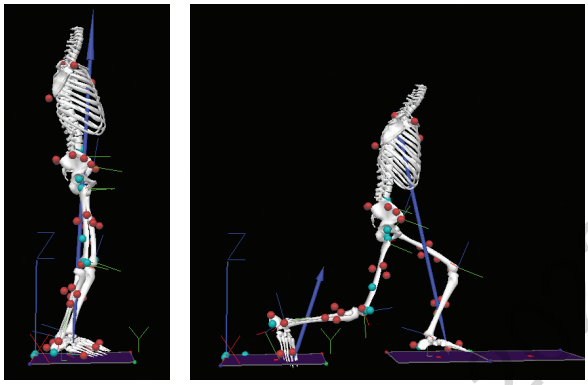

Figure 1: Example of patient perfoming lunge activity.

Results

During the knee strength testing, patients with the BKR limb showed no significant difference in knee extensor strength when compared to healthy controls and 24% more knee extensor strength when compared to TKR limbs. Furthermore, TKR limbs displayed a 35% deficit in knee extensor strength when compared to the healthy controls (Table 1). During the level walking test it was found that patients with the BKR could walk with a speed comparable to the control group. Alternatively, patients with a TKR walked 20% slower than the control group. (P=0.005). During both walking tests, BKR patients demonstrated similar knee mechanics to the control group while patients in the TKR group showed compromised mechanics across multiple categories when compared to the BKR and control groups (Table 1). During the lunge test, the BKR limbs exhibited 14° more flexion than TKR limbs (P=0.033) (Table 1). When sit to stand was performed, the TKR patients exhibited 43% (52.8°) more trunk flexion than control participants (36.6°) and 18% more trunk flexion than BKR(44.8°). The BKR patients exhibited similar trunk flexion and kinetics when compared to the control group (Table 1).

Table 1: Means of walking speed, peak knee extensor moment, peak knee power absorption, and peak knee power production of the BKR, TKR, and control groups.

Test/Activity	Variable	BKR	TKR	Control
Knee Strength	Maximal Isometric Extensor Moment (Nm/kg)	1.77	1.35	2.07
Level Walking	Walking Speed (m/s)	1.34	1.18	1.48
Fast Walking	Peak Extensor Moment (Nm/kg)	1.12	1.28	1.06
	Peak Abduction Moment at Push-Off (Nm/kg)	0.29	0.41	0.35
	Peak Internal Rotation Moment (Nm/kg)	0.43	0.33	0.39
Lunge	Peak Knee Flexion (°)	97.1	82.9	108.1
Sit to stand	Peak Trunk Flexion (°)	44.8	52.8	36.6

Discussion

This study demonstrated that BKR limbs possessed comparable strength, walking speed and mechanics to healthy controls during daily activities such as level walking, fast walking and lunging. Conversely, off-the-shelf TKR limbs, demonstrated deficits in knee strength when compared to the BKR and control groups and presented abnormal knee mechanics during activities of daily living. It was apparent, particularly in the sit to stand activity, that the TKR patients had to use their upper body when standing to help compensate for the weakness in their knees. This could potentially be due to the limitations in TKR such as large bone resections, sacrifice of the cruciate ligaments and the alterations of normal knee geometry. The results of this study demonstrate that the normal knee biomechanics expressed by patients who received the BKR implants could have been a result of the customized implant designs.

1. Heekin, et al; Incidence of bicompartmental osteoarthritis in patients undergoing total and unicompartmental knee arthroplasty: is the time ripe for a less radical treatment?; J. Knee Surg. 2014 Feb;27(1): 77-81

2. Sabatini, et al.; Outcomes of Bicompartmental Knee Arthroplasty: A Review; International Journal of Orthopaedics. 2014 October 23 (3) 100-108.