

WEIGHT-BEARING ASYMMETRY AND CLINICAL MEASURES OF IMPAIRMENT AND FUNCTION BEFORE AND AFTER TOTAL KNEE ARTHROPLASTY

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INTRODUCTION

It is known that weight-bearing asymmetry (WBA) occurs in individuals with unilateral knee osteoarthritis, characterized by preferential unloading of the affected limb. Even after total knee arthroplasty (TKA) intervention, WBA has been identified during common weight-bearing tasks such as walking [1] and sit-to-stand transitions [2]. It is possible that altered movement patterns created by WBA may impede rehabilitation progression following TKA, by reducing the demand on the surgical limb during daily function.

The purpose of this study was to examine the course of change for WBA, measured during transitions between sitting and standing, in individuals with unilateral knee OA before and after TKA. Secondly, the relationships between WBA and clinical measures of knee impairment and physical function were evaluated over the course of rehabilitation.

METHODS

Fourteen people with unilateral knee OA participated (age: 62.6 (7.5) years; BMI: 30.8 (4.9) kg/m²; sex: 7 women and 7 men). Participants in this group underwent TKA and participated in standardized rehabilitation for 9 weeks after surgery. Seventeen people of similar ages to the TKA group (age: 66.8 (6.5) years; BMI: 27.2 (3.5) kg/m²; sex: 8 women and 9 men) were enrolled in a control (CTL) group to allow comparison of WBA.

All participants performed a Five Times Sit-to-Stand Test (FTSST), consisting of a timed sequence of transitions between sitting and standing. During the test, vertical ground reaction force (vGRF) was measured with separate force platforms (PASCO scientific, Roseville, CA) under each foot.

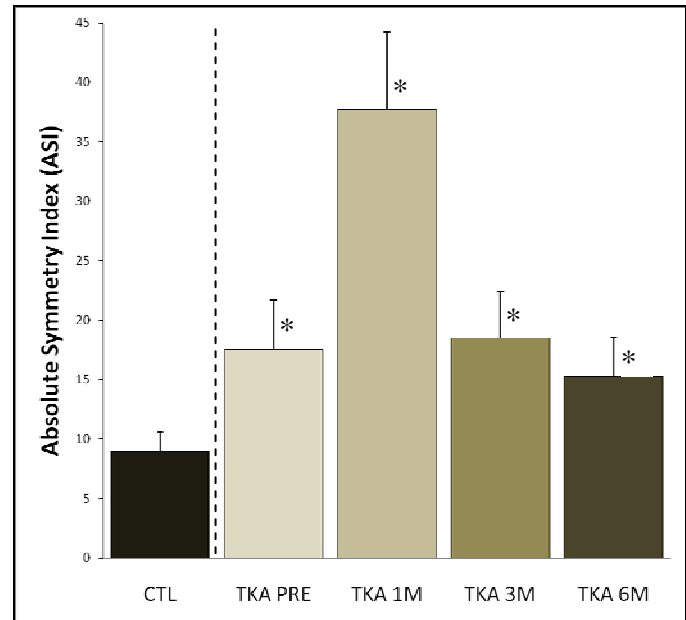


Figure 1: Absolute symmetry index (ASI) for the control (CTL) group and total knee arthroplasty (TKA) group pre- and post-operatively for vertical ground reaction force during transitions between sitting and standing. A value of zero would indicate perfect symmetry. Post-operative months 1, 3, and 6 are indicated by 1M, 3M, and 6M, respectively. *Significant difference compared to CTL group ($p < 0.05$).

Average vGRF during the FTSST was used as the measure of limb loading. An absolute symmetry index (ASI), using absolute limb loading difference, allowed comparison of WBA between TKA and CTL groups.

For the TKA group, measures of knee impairment and physical function were obtained at 1 month, 3 months, and 6 months post-operatively. Knee impairment was assessed using pain, motion, and strength measures. Pain was measured for the involved knee using an 11-item self-report numerical pain rating scale (NPRS) directly following the FTSST. Knee motion was assessed using a manual goniometer to measure degree of active knee extension motion with participants in

supine. Knee extension strength was assessed as maximum knee extension torque using an electromechanical dynamometer (CSMI, Stoughton, MA) with participants seated, hips flexed to 85° and knees flexed to 60°.

Physical function was assessed with two standardized clinical measures: a Six-Minute Walk Test (6MWT) and Stair Climb Test (SCT). The 6MWT measured the total distance walked on a level course in 6 minutes. The SCT measured time to ascend and descend one stair flight (12 steps).

Independent t-tests were used to identify differences in WBA between CTL and TKA groups. Pearson correlation coefficients were used to examine relationships between WBA and all other outcome measures across the time course of rehabilitation. To examine these correlations, a direction specific symmetry value was required. This was calculated as a simple symmetry ratio (SR) of the surgical limb value divided by the non-surgical limb value. A SR was calculated for vGRF during the FTSSST as well as knee motion and strength impairment measures.

RESULTS AND DISCUSSION

Figure 1 illustrates WBA for the TKA group in comparison to the CTL group. Differences were present for WBA between the CTL group and TKA group at all time points. This finding agrees with previous studies for people with TKA [2,3].

Table 1 provides the TKA group correlations of WBA with all outcome measures at all time points. Significant correlations with WBA were identified pre-operatively for knee extension motion and knee extension strength. At all time points after surgery, the SCT was significantly correlated with WBA and the 6MWT was not.

Table 1: Pearson product moment correlations between weight-bearing asymmetry and outcome measurements at progressive time points in relation to surgery.

	PAIN	EXT MOTION SR	STRENGTH SR	6MWT	SCT
Pre-operative	-0.25	-0.47*	0.51*	0.20	-0.34
1M post-operative	<0.01	-0.23	0.05	0.31	-0.49*
3M post-operative	0.04	-0.28	0.42	0.42	-0.61*
6M post-operative	0.09	0.15	0.36	0.44	-0.50*

6MWT = Six-Minute Walk Test, SCT = Stair Climb Test, PAIN = Pain rating on numerical pain rating scale for surgical knee after sit-stand transitions, EXT MOTION SR = Symmetry ratio for extension range of motion, STRENGTH SR = Symmetry ratio for isometric knee extension strength, 1M = 1 month, 3M = 3 month, 6M = 6 month. * p < 0.05 (critical value of r for significance was 0.46)

These results indicate that factors related to WBA change from before to after TKA. Pre-operatively, greater WBA (i.e., lower symmetry ratio) was correlated with less symmetry in knee extensor strength and greater symmetry in knee extension motion. After surgery, correlations between WBA and these knee impairment measures were not significant. Interestingly, knee pain was not correlated with WBA at any time point.

In regards to physical function, relationships with WBA also change from before to after TKA. While no correlations with WBA were present prior to surgery, greater WBA was correlated with poorer function after surgery for the SCT. At all post-operative time points, SCT time was moderately correlated with WBA such that greater WBA was related to worse performance (i.e., longer time for stair ascent and descent). There was no significant correlation between 6MWT and WBA at any time point.

CONCLUSIONS

WBA during transitions between sitting and standing is greater for people with unilateral knee OA prior to and following TKA, when compared to healthy adults of similar age. In addition, relationships between WBA and select measures of knee impairment and physical function change across the course of rehabilitation. Further research is required to determine the viability of targeting WBA for intervention during TKA rehabilitation.

REFERENCES

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