BIOMECHANICAL ASYMMETRY BEFORE AND AFTER TOTAL KNEE ARTHROPLASTY IN SUBJECTS WITH AND WITHOUT BACK PAIN

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INTRODUCTION

Studies estimate that 54 million Americans suffer from low back pain (LBP) [1] and 21 million have osteoarthritis (OA), which commonly affects the weight bearing joints of the lower extremities [2]. Total knee arthroplasty (TKA) is a commonly used surgical intervention for knee OA in which the OA diseased joint is replaced by a prostetic device. To date, limited research exists on the relationship between TKA and LBP, and biomechanical relationships between the development and progression of knee OA and LBP are unclear. Specific symptoms of LBP that are suspected to be risk factors for knee OA resulting in TKA include strength and biomechancial asymmetry. The objective of this study is to quantify knee strength and biomechanical asymmetry among TKA patients either with or without LBP.

METHODS

8 subjects (2 male, 6 female) who had reported LBP were included in Group 1 and 7 subjects (2 male, 5 female) who did not report LBP were included in Group 2. All subjects have undergone TKA and signed the IRB approved informed consent form. Data collection occurred 8 weeks prior to and 12 weeks after TKA (T1 & T4, respectively). Reflective markers were placed in a modified Helen Hayes arrangement and marker spatial coordinates were obtained at 100 Hz with a Hawk Motion Tracking System (Motion Analysis Corp.). A force plate (Bertec Corp.) simultaneously recorded ground reaction force (GRF) at 1000 Hz. Subjects performed a single sit-to-stand repetition with the non-operated leg on the force plate followed by a 30 second trial with the operated leg on the force plate. Knee strength measurements were subsequently obtained using a Biodex Isokinetic Dynamometer. Five outcome measures (Table 1) are presented in this paper. Differences between these outcome measures at T1 and T4 were determined using student t-tests with $p < 0.05$ considered to be significant.

RESULTS

Knee strength, as measured by PTBW, significantly increased by 104% for the non-operated leg and by 38.9% for the operated leg for Group 2 ($p = 0.01$ & 0.02, respectively). For Group 1 however, PTBW increased by only 14.9% for the non-operated leg and 4.5% for the operated leg (Fig 1a).

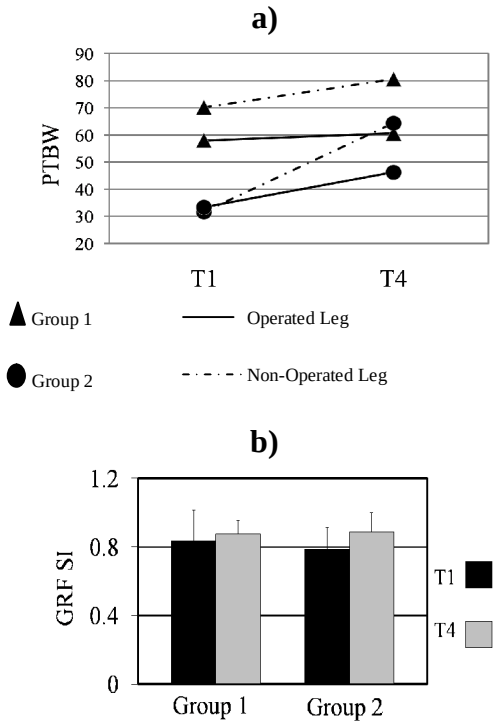

Figure 1: a) Comparison of PTBW during knee extension; b) Comparison of GRF SI during sit-to-stand

GRF SI values for Group 2 increased significantly ($p=0.02$) from 0.79 at T1 to 0.88 at T4 (Fig 1b).

Improvements in GRF SI between T1 and T4 were not seen for Group 1 (GRF SI = 0.88).

Although not statistically significant, subjects in both groups displayed smaller or comparable values for LSD, MLPS, and MLTL at T4 compared to T1 (Table 2). Additionally, subjects without LBP exhibited less trunk kinematic asymmetry at both sessions than subjects with LBP.

Table 2: Average trunk kinematic parameters for Group 1 and Group 2 at T1 and T4

	LSD (mm)		MLPS (mm)		MLTL (^{o})	
	G1	**G2**	**G1**	**G2**	**G1**	**G2**
T1	23.7	8.57	35.05	28.64	5.17	3.08
T4	17.2	10.59	32.14	26.90	4.37	3.84
p	0.22	0.35	0.31	0.39	0.15	0.15

DISCUSSION

Both groups showed significant differences in PTBW changes before and after TKA. Non-LBP subjects (Group 2) exhibited large increases in PTBW while increases for subjects with LBP (Group 1) were much smaller. These findings are in agreement with a previous study that concluded that chronic LBP or reduced endurance of the spinal musculature was associated with significant inhibition of knee extensors [3].

The increase in GRF SI for non-LBP subjects (Group 2) after TKA was not seen in LBP subjects (Group 1). These results indicate that subjects in Group 1 may have developed certain compensatory mechanisms to minimize pain in the surgically repaired knee as well as the lower back, and these compensatory methods were still apparent even after TKA.

CONCLUSIONS

Quantitative biomechanical data collected 8 weeks prior to and 12 weeks after TKA was evaluated for subjects with and without LBP. TKA patients without LBP showed significant improvements in knee extension strength and biomechanical asymmetry during sit-to-stand tasks. Similar trends were not observed in a group of TKA patients with LBP.

ACKNOWLEDGEMENTS

This study was supported by a grant from the NIH (NINR) R01 R008135-01A2

REFERENCES

1. Deyo R, et al., *Spine*. **31**:2724-2727, 2006.
2. Felson DT, et al., *Arth & Rheum*. **41**:1343-1355, 1998.
3. Suter E, et al., *Spine*. **26**:361-366, 2001.

Table 1: Description of outcome measures used in the study

Outcome Measure	Description
Vertical GRF Sym Index (SI)	Peak GRF operated leg/peak GRF non-operated leg
Lateral Seat Displacement	Center shift of the shoulders and ankles while seated prior to sit-stand
Max Lateral Pelvic Shift (MLPS)	Max displacement between centers of pelvis and ankles during sit-stand
Max Lateral Trunk Lean (MLTL)	Angular disp between centers of shoulders and ankles during sit-stand
Peak Torque/Body Wt (PTBW)	Knee flexion/extension strength for operated and non-operated leg