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BIOMECHANICS OF THE NON-OPERATED KNEE BEFORE AND TWO MONTHS AFTER TOTAL KNEE ARTHROPLASTY

¹Eytan M. Debby, ²Benjamin Bernfeld, ¹Arielle G. Fisher, ³Moshe Salai,
³Aviram Gold, ³Aharon Menachem, ³Nadav Shaha, ³Yadin D. Levy ¹Alon Wolf

¹Biorobotics and Biomechanics Lab, Faculty of Mechanical Engineering, Technion Israel Institute of Technology, Israel;

²Department of Orthopedic Surgery, Carmel Medical Center, Israel; ³Division of Orthopedics, Sourasky Medical Center, Israel;
email: edebbi@technion.ac.il, web: brml.technion.ac.il

INTRODUCTION

Total knee arthroplasty (TKA) is the most common treatment for end-stage knee OA, with approximately 500,000 procedures performed each year in the United States. The number of procedures is expected to rise to over three million by 2030 due to population growth, increasing longevity and a rise in obesity [1]. There have been numerous studies on the operated knee before and after unilateral TKA, but there have been fewer studies on the non-operated knee. There is evidence of non-random progression of OA in the other lower limb joints after unilateral TKA, with the non-operated knee being at the greatest risk for OA progression and another TKA [2]. Recent biomechanical studies suggest one reason for the higher rate of OA progression may be limb asymmetry postoperatively, in which the non-operated knee bears greater loads postoperatively than the operated knee [3]. It is unclear, however, whether this is a result of gait changes due to the surgery itself. The present study aimed to examine the preoperative and postoperative biomechanics of the non-operated knee to determine if gait patterns worsen after surgery.

METHODS

Fifty patients were examined before and two months after TKA. Patients underwent a 3D gait analysis using the Vicon Motion Analysis system (Oxford Metrics Ltd., Oxford, UK) and completed a VAS scale for pain. Data from both the operated and non-operated knees were analyzed and compared. Data were compared to a healthy control group using findings from previously published studies.

RESULTS AND DISCUSSION

The study results are presented in Table 1. The non-operated knee did not show significant changes in knee varus angle (KVA) (Figure 1a), knee adduction moment (KAM) (Figure 1b), knee flexion angle (Figure 2a) or knee flexion moment (Figure 2b) after surgery (all $p > 0.05$). Pain in the non-operated knee did not improve significantly after surgery ($p = 0.066$). Changes were not found in spatiotemporal parameters unique to the non-operated knee after surgery. In the coronal plane, the non-operated knee showed similar KVA and KAM preoperatively in comparison to the operated knee, but higher KVA and KAM postoperatively because the both KVA and KAM in the operated knee were reduced by surgery while the non-operated knee remained

unchanged (Figure 1). The limb differences in peak 1 and 2 of KAM were significant ($p = 0.0028$ and 0.005 , respectively). Both before and after surgery, the non-operated knee did not differ significantly from healthy control in KVA or KAM. The knee was significantly worse than controls in pain scores and spatiotemporal parameters (all $p < 0.0001$).

In the sagittal plane, the operated and non-operated knee show similar gait patterns preoperatively. Postoperative deterioration in the operated knee leads to significant limb differences in kinematic and kinetic knee parameters in the sagittal plane after surgery. The operated knee showed significantly lower extension at terminal stance and flexion in swing, as well as a significantly lower knee extension moment compared to the non-operated knee. Regardless of limb differences, loading patterns in the non-operated knee are significantly worse than controls preoperatively and postoperatively (all $p < 0.0001$).

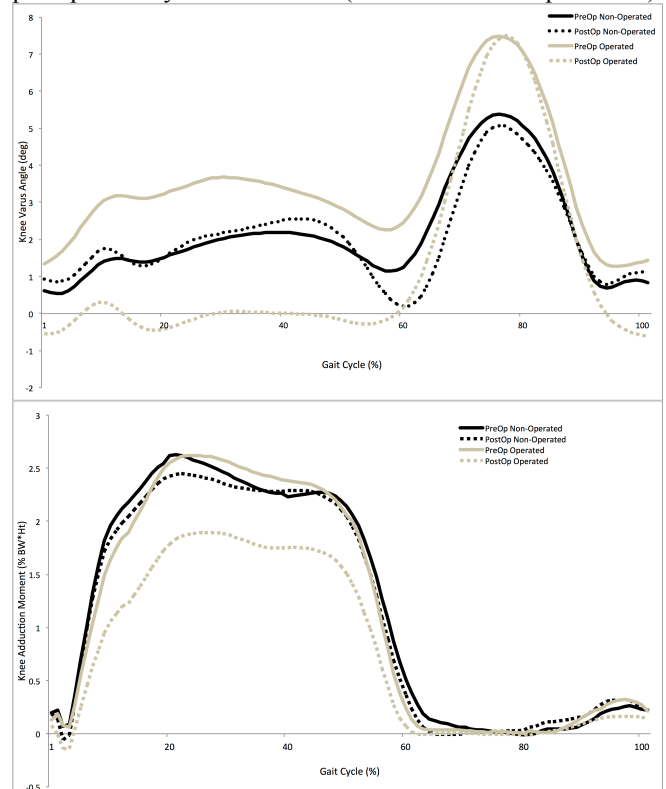


Figure 1: Knee varus angle (a) and KAM (b) in operated and non-operated knees before and after TKA.

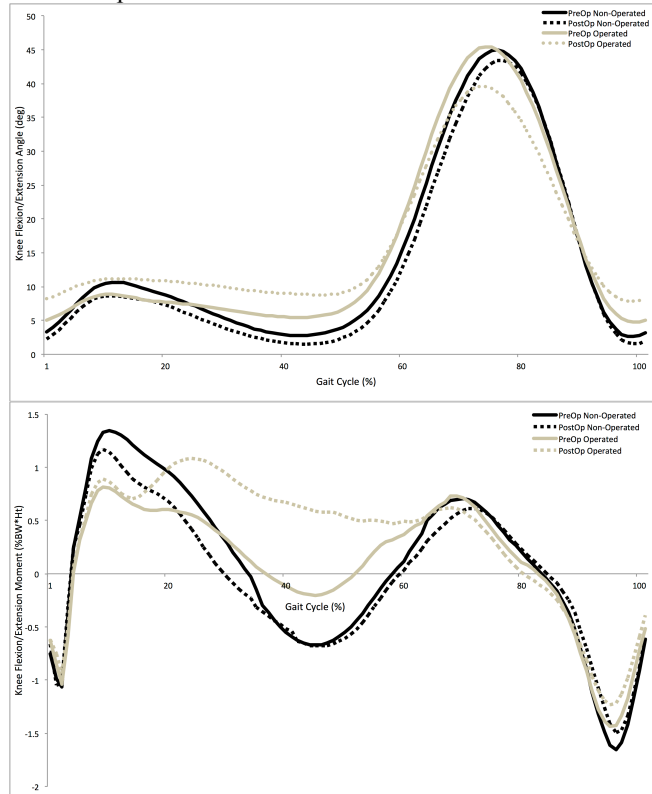


Figure 2: Knee flexion/extension angle (a) and moment (b) in operated and non-operated knees before and after TKA.

CONCLUSIONS

The study's findings suggest that gait patterns in the non-operated knee may not change after surgery. The study confirms that there is a limb asymmetry after surgery, with the non-operated limb bearing greater loads than the operated limb, but suggests that the asymmetry likely results from improvements in the operated knee rather than deterioration in the non-operated knee. As a whole, the findings indicated that the surgery itself might not be the catalyst for higher loading patterns postoperatively. Nevertheless, the non-operated knee may still be at risk for OA after surgery due to the limb asymmetry and the persistent higher levels of KAM. Clinicians should consider this when prescribing therapy to patients postoperatively. There should be a focus on caring for the non-operated knee in addition to the operated knee.

REFERENCES

1. Kurtz SM, et al., *JBJS Am.* **89**:780-785, 2007.
2. Shakoor N, et al., *Arth Rheum.* **46**:3185-3189, 2002.
3. Alnahdi AH, et al., *JOR.* **29**:647-652, 2011.

Table 1:

Parameter	Non-Op	Op	Sig	NonOp	Op	Sig	Pre vs. Post	Healthy vs PreOp	Healthy vs PostOp
Walking speed (m/s)	0.79±0.23		NA	0.72±0.22		NA	0.034*	<0.0001**	<0.0001**
Stride Length (cm)	93.1±24.7		NA	91.5±19.2		NA	0.148	<0.0001**	<0.0001**
Cadence (s ⁻¹)	0.97±0.15		NA	0.93±0.13		NA	0.021*	<0.0001**	<0.0001**
Step length (cm)	46.7±10.6	47.1±10.3	0.854	44.2±10.0	45.4±10.7	0.559	0.050	<0.0001**	<0.0001**
Single limb support (% Gait Cycle)	35.4±4.4	33.6±5.1	0.034*	36.4±3.7	32.8±5.0	<0.0001**	0.05	0.900	0.087
Double Limb Support (% Gait Cycle)	30.6±8.5	30.3±7.9	0.852	30.3±7.2	30.2±7.1	0.928	0.792	0.422	0.52
Peak varus angle (deg)	3.1±5.6	4.5±8.4	0.131	3.4±5.2	1.4±5.3	0.061	0.398	0.599	0.404
Peak Flexion Angle in Stance (deg)	11.5±7.6	10.2±7.3	0.354	10.0±6.3	12.2±6.4	0.079	0.053	<0.0001**	<0.0001**
Peak Extension Angle in Stance (deg)	1.9±7.3	4.5±6.7	0.064	0.51±6.7	7.9±6.3	<0.0001**	0.084	0.089	0.004**
Peak Flexion Angle in Swing (deg)	47.3±10.0	47.3±10.6	0.990	46.0±8.6	41.2±9.0	0.007**	0.199	<0.0001**	<0.0001**
Range of motion (deg)	45.5±10.4	42.9±10.3	0.216	45.5±9.1	33.4±8.7	<0.0001**	0.930	<0.0001**	<0.0001**
Peak varus angle (deg)	3.1±5.6	4.5±8.4	0.131	3.4±5.2	1.4±5.3	0.061	0.398	0.599	0.404
Peak adduction moment 1 (%BW*Ht)	3.0±1.2	3.1±1.5	0.721	2.8±1.1	2.2±0.81	0.0028**	0.085	0.528	0.780
Peak adduction moment 2 (%BW*Ht)	2.4±1.1	2.6±1.4	0.398	2.5±1.0	2.0±0.86	0.005**	0.762	0.264	0.148
Peak Flexion Moment (%BW*Ht)	1.7±1.3	1.4±1.1	0.145	1.6±1.5	1.6±1.3	0.941	0.406	0.027*	0.081
Peak Extension Moment (%BW*Ht)	-1.2±1.3	-1.0±1.3	0.387	-1.2±1.2	-0.32±0.89	<0.0001**	0.843	0.0035**	0.0008**
VAS Scale for Pain	3.2±2.9	7.2±2.0	0.001**	2.6±2.2	5.7±2.0	0.001**	0.066	<0.0001**	<0.0001**

VAS=Visual analog scale

* = less than 0.05; ** = less than 0.01