

BIOMECHANICAL DIFFERENCES OF DISSATISFIED TOTAL KNEE REPLACEMENT PATIENTS DURING STAIR DESCENT

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INTRODUCTION

Stair negotiation is one of the more difficult daily activities reported by total knee replacement (TKR) patients. Patient dissatisfaction with TKR outcomes ranges from 6-19%, with patients often citing an inability to perform certain activities. Dissatisfied TKR patients have reported increased difficulty with stair negotiation, however it is unknown what the underlying mechanical issues are for this population. Therefore, the purpose of this research was to examine the knee joint biomechanics of dissatisfied TKR patients during stair descent.

METHODS

A total of nine dissatisfied TKR patients (34.6±14.3 months from surgery), 15 satisfied TKR patients (29.3±12.8 months from surgery), and 15 healthy participants performed stair descent trials on a five-step instrumented staircase at a preferred gait speed. Patient satisfaction was assessed using a five point Likert scale (very dissatisfied, dissatisfied, neutral, satisfied, very satisfied), with neutral responses being excluded. Kinematics and kinetics were measured using a 12-camera Vicon motion analysis system (240Hz) and two AMTI force platforms (1200Hz) to which the staircase was secured. Internal knee joint moments and ground reaction forces were calculated using Visual3D. A 2x3 (limb x group) mixed model ANOVA was used for statistical analysis (p<0.05).

RESULTS AND DISCUSSION

There were significant interactions for 1st and 2nd peak knee extension and abduction moments (Table 1). The dissatisfied group showed lower knee extension and abduction moments in their replaced limb. The 2nd peak vertical ground reaction force (VGRF) and 1st and 2nd peak knee internal rotation moments showed lower moments for replaced limbs compared to non-replaced limbs. First peak VGRF was reduced for dissatisfied group compared to

satisfied and healthy groups. The dissatisfied TKR group had significantly increased pain levels on their replaced limb compared to all other groups and limbs. The dissatisfied group had reduced gait speed compared to the satisfied and healthy groups.

Reductions in knee extension moments have previously been shown to occur with reductions in gait speed for TKR patients [1]. The reduction for the dissatisfied group in their replaced limb may be related to the joint pain, which in turn causes them to walk slower. Increased pain and slower speed may lead to an extension moment avoidance gait pattern which alters the gait, creating some additional joint moment reductions in the frontal plane. This renders the given task more difficult to complete.

CONCLUSIONS

Increased pain levels lead to reduced descent speed and peak loading-response and pushoff sagittal plane knee joint moments in dissatisfied total knee replacement patients during stair descent. This creates an asymmetry in the extension loading response moment for the dissatisfied group, with the non-replaced limb showing increased joint moments whereas the satisfied and healthy groups do not have that imbalance. This contributes to reduced gait speed due to an inability to load the replaced knee compared to the non-replaced knee.

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REFERENCES

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Table 1. Peak Vertical Ground Reaction Force (BW), Internal Knee Joint Moments (Nm/kg), Pain levels (0-10), and Gait Speed (m/s) during stair descent.

| | Dissatisfied Replaced | Dissatisfied Non-Replaced | Satisfied Replaced | Satisfied Non-Replaced | Healthy | Interaction p value |
|--|---------------------------|---------------------------|------------------------|-------------------------|------------|---------------------|
| 1 st Peak VGRF [#] | 1.24±0.25 | 1.34±0.19 | 1.52±0.19 | 1.59±0.19 | 1.44±0.09 | 0.2213 |
| 2 nd Peak VGRF [*] | 0.91±0.05 | 0.97±0.09 | 0.87±0.05 | 0.93±0.07 | 0.89±0.10 | 0.0600 |
| 1 st Peak Ext. Moment | 0.39±0.22 ^{ABCD} | 0.69±0.34 | 0.74±0.23 | 0.83±0.29 | 0.85±0.31 | 0.0079 |
| 2 nd Peak Ext. Moment | 0.78±0.17 ^{ABD} | 1.09±0.27 ^B | 0.88±0.26 ^A | 1.05±0.23 | 0.95±0.18 | 0.0022 |
| 1 st Peak Abd. Moment | -0.40±0.17 ^{BD} | -0.56±0.13 | -0.61±0.21 | -0.55±0.23 ^D | -0.69±0.19 | 0.0002 |
| 2 nd Peak Abd. Moment | -0.35±0.19 ^D | -0.48±0.18 | -0.41±0.18 | -0.36±0.14 ^D | -0.51±0.11 | 0.0002 |
| 1 st Peak Int. Rot Moment [*] | 0.10±0.04 | 0.13±0.10 | 0.13±0.06 | 0.17±0.08 | 0.08±0.05 | 0.4313 |
| 2 nd Peak Int. Rot. Moment [*] | 0.14±0.07 | 0.20±0.10 | 0.18±0.08 | 0.20±0.07 | 0.12±0.05 | 0.2498 |
| Pain | 3.39±2.42 ^{ABCD} | 0.00±0.00 | 0.00±0.00 | 0.13±0.52 | 0.07±0.26 | <0.0001 |
| Gait Speed [#] | 0.44±0.16 | | 0.64±0.09 | | 0.63±0.09 | NA |

^A Significantly different from contralateral leg of same TKR group, ^B Significantly different from contralateral leg of satisfied TKR group, ^C Significantly different from same leg of satisfied TKR group, ^D Significantly different from healthy group.

[#]Group Main Effect (p<0.05), ^{*}Limb Main effect (p<0.05).