COMPARISON OF UNICOMPARTMENTAL KNEE ARTHROPLASTY AND HEALTHY LIMB FOR KNEE MOMENTS GENERATED DURING STAIR ASCENT

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INTRODUCTION

With improvement of implant design and surgical techniques, use of unicompartmental knee arthroplasty (UKA) has increased recently [1]. This surgery replaces the most damaged knee compartment, either the medial (MED) or lateral (LAT). However, biomechanical evidence to support the efficacy of UKA is still lacking, especially LAT-UKA. Stair ascent is a high-demanding functional activity. Interlimb asymmetry is a common clinical indicator to evaluate performance after joint reconstruction and to identify abnormal mechanics. Atypical joint mechanics are associated with osteoarthritis (OA) progression and implant wear [2]. Therefore, the purpose of the study was to compare the interlimb symmetry of the knee joint moments displayed during stair ascent of MED-UKA and LAT-UKA individuals.

METHODS

17 MED-UKA (14 iBalance Unicondylar Knee®, Arthrex; 3 Zimmer® Unicompartmental High Flex Knee System, Zimmer), and 9 LAT-UKA (6 iBalance; 3 Zimmer) healthy participants were recruited (Table 1) [3]. Leg dominance was defined as the limb used to kick a ball. All participants had a UKA performed by the author (OMM) at least 6 mo. prior to testing (range: 6 mo to 3 yr). All participants provided informed consent. Reflective markers (30) were placed on the lower body segments. Marker trajectories were captured using high-speed cameras (120 fps). Ground reaction forces were collected at 1200 Hz via a force platform mounted in the floor and another flush with the 1st step. Participants walked up 4 stairs barefoot at a self-selected speed starting with 1 limb for 5 trials and then the other limb for another 5 trials. The order of starting limb was counterbalanced among participants.

Knee moments were generated for each limb of the support phase of the 1st step. Different knee moment patterns among participants existed [3]. Therefore, variables common to all patterns were analyzed: peak knee extensor, abductor, and external rotator moment magnitudes and times to those peak moments. Paired t-tests were applied to determine interlimb differences within each UKA group (α = 0.05). A difference score for each variable was determined: value of UKA minus nonUKA limb. 95% confidence intervals (CIs) of difference scores also were reported.

RESULTS AND DISCUSSION

No interlimb difference was detected for ascent stride velocity (Table 1). The average ascent velocities of both groups were slower than a reported value (0.44 ± 0.06 m/s) for stair ascent of healthy older adults [3]. No time to peak moments were significantly different (p = 0.263 - 0.937), likely due to interparticipant variability.

For moment magnitudes, the MED-UKA group displayed greater peak extensor moment for the nonUKA limb than the UKA limb (Table 2). The extensor moment is generated to raise the body during the support phase. One possible reason for this outcome may be related to differences in leg strength, although this is not known from our data. Weaker leg strength of total knee replacement limbs has been reported [4]. Another explanation is that UKA individuals might also protect their surgical
limb by leaning the body to the non-diseased limb. Habituation of limb protection has been shown for other populations [5]. However, this suggestion also cannot be proven at present. Limb dominance is not a likely reason (Table 1). Peak extensor moments of the UKA limb of both groups (MED: 1.21 ± 0.19; LAT: 1.02 ± 0.17 N·m·(body mass · leg length)⁻¹) were similar to values (1.30 ± 0.23) in the literature [3], suggesting that the moments generated by LAT- and MED-UKA groups are not abnormal.

In both groups, UKA limbs demonstrated greater peak abductor moments than nonUKA limbs. A possible reason may be the preference to shift the center of mass toward the nonUKA limb, thereby requiring greater abductor moment during late stance phase. A similar strategy has been noted during level walking for OA population [5], and it is reasonable that UKA population uses same strategy during stair ascent. Therefore, OA progression and implant wear may be of concern for the MED-UKA and LAT-UKA groups, respectively [2, 5, 6].

Sample size was a study limitation, especially on LAT-UKA group. Posthoc power analysis showed that desired group sample size was 20.

**CONCLUSIONS**

In conclusion, both MED- and LAT-UKA individuals demonstrate adequate knee extensor moments during stair ascent for both limbs compared to the literature. Greater UKA limb abductor moments were displayed by both groups. However, whether these differences are clinically significant and related to abnormal wear on the affected articular surfaces needs further examination.

**REFERENCES**


**Table 1:** Participant characteristics (mean ± SD). Also presented: Average stride velocity (m·s⁻¹) and frequency of participants (% participants) whose UKA limb was their dominant limb.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender (n)</th>
<th>Age (yrs)</th>
<th>Height (cm)</th>
<th>Mass (kg)</th>
<th>Stride Velocity (m·s⁻¹)</th>
<th>Leg Dominance Freq (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MED-UKA</td>
<td>M: 6; F: 11</td>
<td>68.0 ± 7.4</td>
<td>162.7 ± 7.1</td>
<td>74.1 ± 12.3</td>
<td>0.38 ± 0.08</td>
<td>58.8</td>
</tr>
<tr>
<td>LAT-UKA</td>
<td>M: 3; F: 6</td>
<td>63.1 ± 7.8</td>
<td>167.2 ± 6.4</td>
<td>71.1 ± 13.3</td>
<td>0.37 ± 0.05</td>
<td>77.8</td>
</tr>
</tbody>
</table>

**Table 2:** Means (\(\bar{X}\)) and 95% confidence interval (lower (LB) and upper (UB) bound) of difference scores for peak knee joint moment magnitudes (N·m·(body mass · leg length)⁻¹).

<table>
<thead>
<tr>
<th></th>
<th>MED-UKA</th>
<th>LAT-UKA</th>
<th>p</th>
<th>MED-UKA</th>
<th>LAT-UKA</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensor Moment</td>
<td>-0.08</td>
<td>-0.16</td>
<td>-0.01</td>
<td>*0.030</td>
<td>-0.36</td>
<td>*0.087</td>
</tr>
<tr>
<td>Abductor Moment</td>
<td>0.22</td>
<td>0.08</td>
<td>0.36</td>
<td>*0.005</td>
<td>0.15</td>
<td>0.26</td>
</tr>
<tr>
<td>External Rotator Moment</td>
<td>-0.02</td>
<td>-0.06</td>
<td>0.02</td>
<td>0.298</td>
<td>-0.01</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

Note. A positive or negative value indicates the UKA limb was greater or lesser, respectively, than the nonUKA limb. * = significant difference (\(p < 0.05\)).