INTRODUCTION:
While modern total hip arthroplasty (THA) allows regain of mobility, biomechanical impairments persist even 10 years after surgery [1]. Other activities of daily living than walking need investigation, such as rising from a chair. Sit-to-stand is a task requiring greater range of motion than walking, and that is performed in everyday life. THA patients have been shown to exhibit asymmetrical vertical ground reaction forces [2; 3] while performing this task. Several factors can affect the mechanics of THA patients after surgery, such as age and weight, and surgical approach. It is thought that a muscle sparing anterior (ANT) approach could allow better mechanics because it spares the abductor muscle group.

The purpose of this study is to evaluate the effect of surgical approach on the asymmetry of the kinetics of the hip and knee during a sit-to-stand motion. It is hypothesized that, compared to a traditional lateral (LAT) surgical approach, the anterior approach will allow better symmetry in lower limb kinetics.

METHODS:
A total of 60 participants were recruited: 20 patients that had THA by means of an ANT approach (14 women, 6 men; age: 62 ± 6 yr; BMI: 28 ± 5 kg/m²), 20 patients by means of a LAT approach (10 women, 10 men; age: 67 ± 7 yr; BMI: 27 ± 5 kg/m²) and 19 healthy participants (CON) (9 women, 10 men; age: 62 ± 4 yr; BMI: 25 ± 3 kg/m²) matched for age and BMI. All patients did not have any other known condition that could alter gait. Patients were tested, on average, 11 ± 3 months (LAT group) and 10 ± 4 months (ANT group) after surgery. The study has been approved by the institution’s research ethics board. Informed consent was obtained prior to the data collection.

Three-dimensional kinematics were obtained at 200 Hz using a nine-camera digital optical motion capture system (Vicon MX, Vicon Motion Systems, Oxford UK). Forty-five reflective markers were placed on the participant’s body on specific landmarks following a modified Helen Hayes model. Three-dimensional ground reaction forces were obtained at 1000 Hz with two force platforms (model OR6-6,000, AMTI, Watertown, MA, USA) placed side by side. A height-adjustable bench was set at each participant’s tibial plateau height.

Participants performed three trials of standing up from a seated position with their arms in front of them to avoid hiding markers. Each joint (hip, knee and ankle) was defined as having three degrees of freedom (flexion/extension, abduction/adduction and external/internal rotation). Angles are reported in relation to each participant’s neutral joint using an inverse dynamics approach. Vectors of interest were peak hip and knee extension moments, the peak extension support moment (sum of hip, knee and ankle moments), as well as hip and knee peak powers. The net difference in the peak values for each variable was calculated, as well as an asymmetry index (Aᵦ) adapted from Robinson et al. [4]. The formula used was:

\[ Aᵦ = \left( \frac{V_{\text{op}} - V_{\text{op')}}{\frac{1}{2} \left( |V_{\text{op}}| + |V_{\text{op'}}| \right)} \right) \times 100\% \]

Where \( V_{\text{op}} \) and \( V_{\text{op'}} \) are the values of each variable of interest for the non-operated side (NO) and operated side (OP), respectively. The index can vary between -100 and 100; a negative value indicates a non-operated side favoring, and a zero value a perfect symmetry. One-way ANOVAs (α=0.05) were performed on the average asymmetry indexes of the three groups using SPSS v15.0 (SPSS Inc. Chicago, IL).

RESULTS:
A one-way ANOVA firstly confirmed the three groups were not significantly different in age and BMI (age: \( p=0.363 \); BMI: \( p=0.538 \)). It was found that the CON participants had average absolute \( Aᵦ \) between 8 and 9.5%, for the variables of interest. Therefore, a threshold of 10% was defined as the limit of a symmetric loading. Ratios of side-favoring and results of an ANOVA on the mean \( Aᵦ \) are presented in Table 1. For peak hip extension moment, 4 out of 20 patients in the LAT group were symmetric, 2 favored their OP hip (\( Aᵦ: 27 ± 5\% \)), and 14 favored their NO hip (\( Aᵦ: -28 ± 19\% \)). The ANT group had similar results: 4 favored their OP hip (\( Aᵦ: 17 ± 6\% \)), 10 their NO hip (\( Aᵦ: -26 ± 15\% \)), and 6 were symmetric. A one-way ANOVA showed an effect of group on peak hip extension moment \( Aᵦ (p=0.021) \). Post-hoc Tukey’s comparisons of the average \( Aᵦ \), for each group revealed that the LAT group significantly favored their NO side (\( p=0.016 \)) compared to the CON group, but not the ANT group (\( p=0.215 \)). Similar results were obtained for the peak extension support moment, where the LAT group had a significantly greater asymmetry than the CON group (\( p=0.029 \)), but not the ANT group (\( p=0.252 \)). Again, most THA patients favored their NO leg (16 for the LAT group and 14 for the ANT group). Hip power showed similar results, with both groups being significantly more asymmetric than the CON group. There was less asymmetry at the knee. While both THA groups mostly favored their NO side, there was no difference with the CON group.

Table 1. Ratios of side favored and post-hoc test of ANOVA vs CON.

<table>
<thead>
<tr>
<th>Variables</th>
<th>ANT</th>
<th>LAT</th>
<th>Post-hoc p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip extension moment</td>
<td>4:0:6:6</td>
<td>2:1:4:4</td>
<td>0.016*</td>
</tr>
<tr>
<td>Knee extension moment</td>
<td>4:0:6</td>
<td>4:8:8</td>
<td>0.664</td>
</tr>
<tr>
<td>Sum of moments</td>
<td>4:8:8</td>
<td>5:12:6</td>
<td>0.252</td>
</tr>
<tr>
<td>Hip generated power</td>
<td>4:13:3</td>
<td>2:1:1:7</td>
<td>0.046*</td>
</tr>
<tr>
<td>Knee generated power</td>
<td>4:7:9</td>
<td>6:1:0:4</td>
<td>0.598</td>
</tr>
</tbody>
</table>

Significant difference at \( \alpha=0.05 \).

DISCUSSION:
It was found that several THA patients of both the ANT and LAT group had asymmetric moments and powers at the hip and knee joints. Regardless of the variable of interest, 10 patients in the ANT group and 11 in the LAT group favored their non-operated side with an Aᵦ of at least 10%. There were few THA patients that favored their operated side. This clearly indicates that regardless of the surgical approach used, THA patients are still reluctant in using their operated leg in conditions that necessitate slightly greater effort in hip extension, such as standing from a chair. The results also indicated that there is less asymmetry at the knee joint than the hip joint. While the variables measured are not direct joint contact forces, these results are encouraging in respect of the current concerns on accelerated wear of the knee joints after THA. This study did not demonstrate better symmetry for patients operated by means of an anterior approach. In fact, these results were similar to those of the group operated through a lateral approach.

Several factors could explain the level of asymmetry observed in our THA patients. Pain prior to surgery could have lead to disuse and prolonged weakness of the hip musculature. Alternatively, patients could have started disusing their operated side after surgery, either from the trauma inherent from the procedure, or from the lack of proprioception from the prosthetic hip. The exact cause cannot be identified from this study alone, but the results here-presented reveal that surgical approach might not be a very important factor in restoring symmetry during a sit-to-stand motion after THA.

REFERENCES: