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Fall of a transfemoral amputee fitted with osseointegrated fixation: loading impact on residuum

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SUMMARY - This study presented the characteristics of the loading impact on the residuum of a transfemoral amputee fitted with an osseointegrated fixation during a fall for the first time. The maximum force (1,145 N = 132 % of the body weight and moments (153 N.m) were applied on the long and medio-lateral axes, respectively, approximately 0.85 s after heel contact of the prosthesis.

INTRODUCTION

Falling is a common issue for transfemoral amputees [1]. It is particularly critical for those fitted with an osseointegrated implant as a fall may result in the bending of the abutment. The long term effect might be a fracture of the abutment due to fatigue. So far, previous biomechanical studies involving transfemoral amputees fitted with a socket compared kinematic and kinetic characteristics of faller and non-fallers during walking [2]. The purpose of this study is to present the characteristics of the loading impact on the residuum of a transfemoral amputee fitted with an osseointegrated fixation during a fall.

PATIENTS/MATERIALS AND METHODS

One fully rehabilitated female transfemoral amputee (34 yr, 1.7 m, 92.95 kg) participated in the study. She walked at a self selected speed with a prosthesis including a multiaxial transducer (JR3 Inc) and her usual knee and foot. The fall occurred inadvertently on the last stride of walking along a circle with her prosthesis inside [3]. The forces and moments were measured at the sampling rate of 200 Hz by the transducer mounted between the knee and the fixation.

RESULTS

Figure 1. Resultant force and moment applied on fixation during the fall.

<table>
<thead>
<tr>
<th>Heel contact</th>
<th>End of support</th>
<th>Impact</th>
<th>Rolling on side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (N)</td>
<td>Time (s)</td>
<td></td>
<td>Moment (N.m)</td>
</tr>
<tr>
<td>0</td>
<td>-0.2</td>
<td>0.0</td>
<td>0.6</td>
</tr>
<tr>
<td>200</td>
<td>0.2</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>600</td>
<td>0.6</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>1,145</td>
<td>0.8</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>180</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

F - Fn, M - Mn
The end of the support on the prosthesis and the impact on the floor occurred approximately 0.24 s and 0.88 s after the heel contact, respectively. The maximum force applied during the impact of the residuum on the floor was 562 N, 269 N and 1,145 N on the antero-posterior, medio-lateral and long axes corresponding to 62 %, 29 % and 132 % of the body weight, respectively. The maximum moment was 22 N.m, 153 N.m and 30 N.m on the antero-posterior, medio-lateral and long axes, respectively.

DISCUSSION

The protocol was initially designed for another purpose (e.g., direct measurement of the load applied during walking around a circle). The fall was an unforeseen event that was attributed to a faulty knee afterward. So, the sampling frequency of the transducer might be too low to fully assess the impact. Useable kinematic information is also lacking. However, this study provided an overview of the sequence of events and duration of each phase leading to the impact. For instance, the impact on the floor occurred 0.64 s after the prosthesis failed to provide any support. Further analyses of the previous steps are needed to determine if some pattern abnormalities could be seen and, therefore, used to prevent the fall.

CONCLUSIONS

This study provided valuable information (e.g., magnitude of loading at impact, sequence of falling events and duration of key phases) that can be used to design protective equipment and to refine design of osseointegrated fixation.

REFERENCES