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Title

Hip Moment after Trans-femoral Amputation - Comparison of Isometric and Auxotonic Hip Moment in Amputees and Normals

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Summary

The presented results allow a good assessment of muscle changes associated with an amputation its late effects. The comparison of isometric and auxotonic measurements shows which hip moments occur during gait, and which isometric maximums are possible.

Introduction

As a result of arterial occlusive disease, trauma, infection or tumors amputation of a limb can become necessary. The irreversible loss of a limb confronts the patient with a high level of psychological distress and a decrease in his/her physical integrity. In the interest of further improving the prosthesis design, it is necessary to fully and objectively investigate and evaluate the specific situation after an amputation. This paper deals with an objective assessment of hip kinetics of amputees using the new measuring system Hiptor [1,3]. A study performed with a total of 20 volunteers provided information on the trends and magnitude of differences between amputees and non-amputees with respect to the torques and forces at the hip.

Methods

In order to capture the physical measure, in this case the hip moments, instrumental gait analysis [2] and the Hiptor equipment was used [1.3]: the former for the auxotonic measurements, and both combined for the instrumental gait analysis to determine the isometric hip moment. To achieve the goal of this investigation, two groups were included, the first group consisting of subjects without physical disabilities, the second of patients with unilateral trans-femoral amputation. The calculation method for determining the isometric forces and moments used three segments. The first segment, pelvis, was determined using the same method as in PlugIn Gait [1,4,5]. The two other segments, left and right thigh, were generated by using two

additional markers. The hip joint centers were also determined along the lines of the calculation methods in PlugIn Gait. Wilcoxon test was conducted.

Results

The study focused on ten patients and ten able bodied volunteers. Isometric and auxotonic muscle forces and joint moments were averaged and normalized, yielding the values listed in the appendix. According to the isometric measurements there are significant differences in the abduction, adduction and flexion force development between healthy and amputated participants, whereas the differences in extension are smaller (figure 2). The results from the gait analyses measurements were compared with the respective isometric maximal values. The differences are shown in figure 1. Only during the flexion, the isometric level of force is achieved, whereas no adduction moment was observed during gait. Those results were compared with typical gait analysis data of Normals. It was found that all measured torques were lower in the amputee group, most notably for the adduction. The lowest differences with about ten per cent were found for the flexion direction (figure 3). All graphical representations demonstrate the severe variance within the measurement groups. Irrespective of that, the relative deviation in most principal movement directions is considerable.

Conclusion

After an amputation in general, a change in muscle balance or force balance arises, caused not only by the loss of muscles directly acting on the hip, but also the entire lower leg segments and their associated biomechanical functions. Without having to consider the complex muscle interactions in detail, It is obvious that the forces in a healthy person are well balanced. However, this does not mean that all muscles are equally strong as one as evident from our findings for the control group. With a change in the boundary conditions due to an amputation, establishing a new balance is required. The gait measurements of the hip moments in the patient group showed that in flexion the level of the isometric measurement was reached. This was not the case for the other directions, as for the adduction only 2.5%, for the extension movement 45.8% and for the abduction 53.9% of the isometric maximum was reached.

References

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Image: results figure 1-3_None.JPG

figure 1: auxotonic (purple) and isometric (blue) hip moments of amputee group, averaged and normalized to body weight. Isometric, measured with prosthesis.

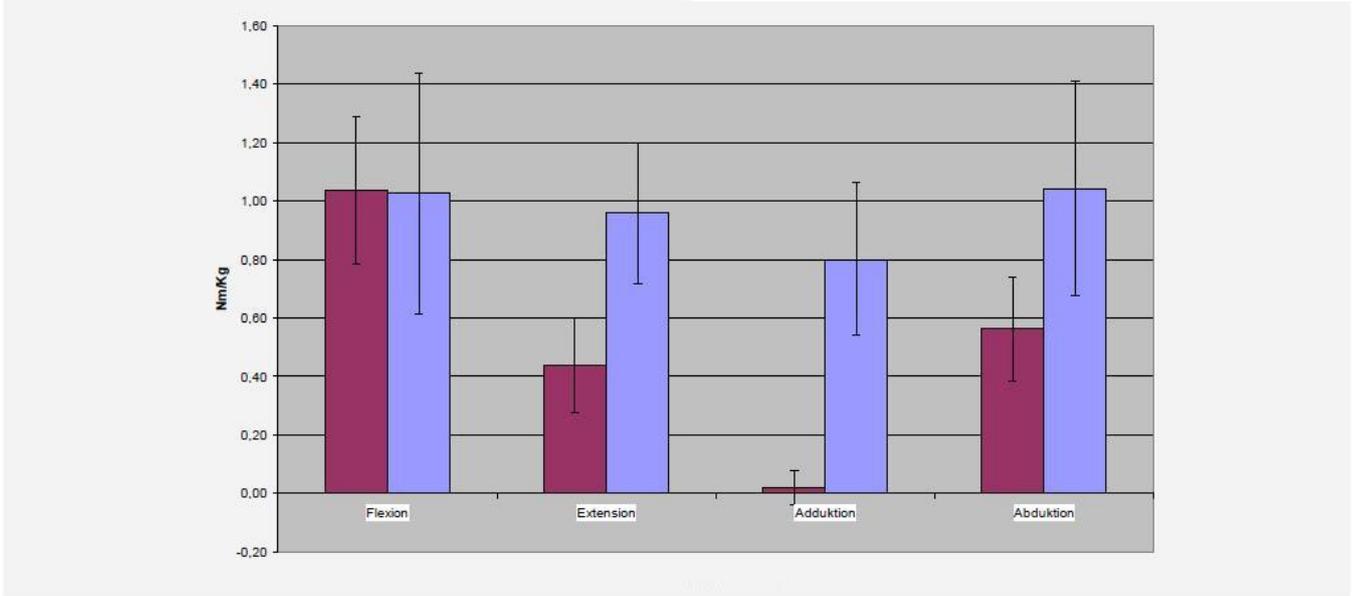


figure 2: Isometric muscle forces of normal- (blue) and amputee group (purple), averaged and normalized to body weight. Measured at same level.

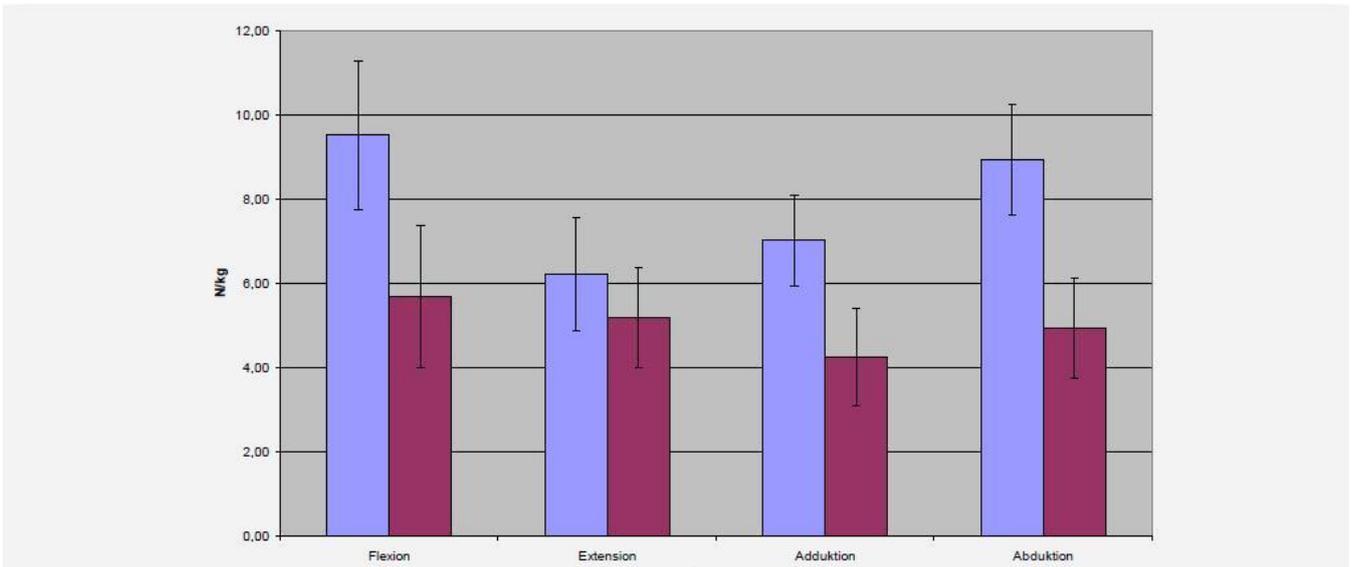


figure 3: Auxotonic hip moments of normal- (blue) and patient group (purple), averaged and normalized to body weight.

