Intersession variability in biomechanical gait parameters of a person with a transfemoral amputation – Results of a multicenter study

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Summary

The natural variability in joint kinematics and kinetics during walking can influence the interpretation of gait data. The aim of this study was to identify the variability in certain gait parameters of persons with a transfemoral amputation (TFA) induced by different sessions and study centers. We found that the intersession variability was in some cases larger than the mean standard deviations of the single sessions and, thus, should be considered when interpreting gait data.

Introduction

A certain variability in joint kinematics and kinetics during walking is natural [1]. In addition, there is a variability caused by the measurements themselves. How reliable different gait measurements, marker protocols and models work was frequently investigated for able-bodied subject e.g. [2]. However, such studies are rare for TFA [3].

Methods

As part of a multicenter study one TFA participated in total five times in a gait analysis, three sessions in Lab-A and one session each in Lab-B and Lab-C. Each laboratory was equipped with force plates and a 3D motion capture system.
Level ground walking with three different self-selected speeds (normal, slow, fast) was measured and a 3D motion analysis performed afterwards.
For each session, the range of motion (ROM) of the sagittal leg angles as well as walking speed, step length, stance phase duration and vertical ground reaction force (vGRF) were calculated. The variability of these parameters within and across sessions as well as the influence of the actual walking speed (regression models) were analyzed.

Results

Intra- and inter-session variability depends on the parameters and condition. E.g., during normal walking, the prosthetic side sagittal ankle and knee angles ranged from 25.1±0.4deg to 26.3±0.7deg and 67.2±0.8deg to 68.8±0.7deg, respectively, in Lab-A, showing low intra-session variability. Sound side ankle and knee angles varied from 14.1±2.1deg to 17.9±1.6deg and 55.4±1.9deg to 61.3±1.9deg in Lab-A. Mean values from Lab-B and Lab-C were in the mean value range of Lab-A (figure 1A). The smallest standard deviations were found for the prosthetic ankle and knee ROM (below 1deg). Values for the sound side and the residual hip were generally higher (0.8 to 2.4deg).
Another finding is that strong correlations (R^2>0.9) exist between walking speed and step length, prosthetic ankle ROM, and sound side vGRF (figure 1B).

Discussion and Conclusions

The difference between mean parameter values of different sessions can be interpreted as a measure of the inter-session variability. These differences were in some cases larger than the mean standard deviations of the single sessions. Therefore, the between-session differences in some parameters reached statistical significance (post hoc tests), even though the conditions were similar. For some parameters, the variance can be reduced by taking walking speed (covariate) into account.
These findings should be considered when interpreting gait data of individual subjects or small groups e.g., when comparing different prostheses.

References

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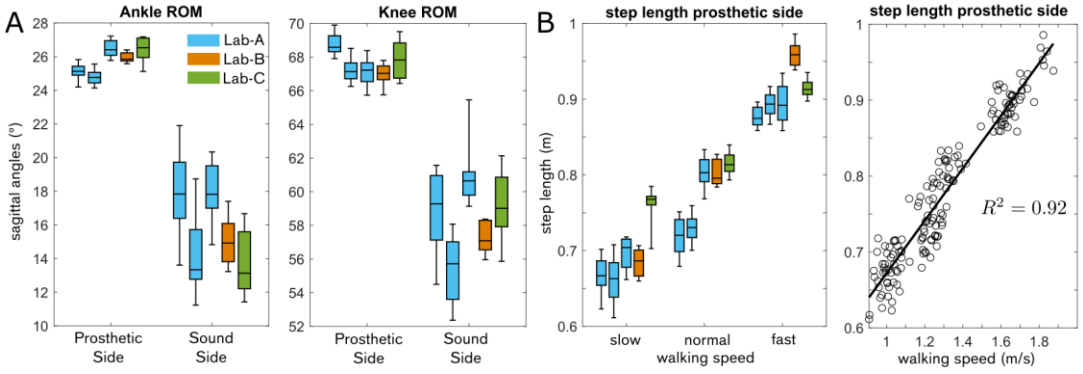

Figure 1: (A) Sagittal ankle and knee ROM for both sides. (B) Step length of prosthetic side for different walking speeds.