ASSESSMENT OF GAIT SYMMETRY IN TRANSFEMORAL AMPUTEES USING C-LEG COMPARED WITH 3R60 PROSTHESIS

[1]Andreas Overbeck Petersen, [2]Jonathan Comins, and [1]Tine Alkjær
[1]University of Copenhagen, Department of Neuroscience and Pharmacology, Division of Biomechanics,
[2]Sahva, Denmark; email: andreasoverbeck@hotmail.com

INTRODUCTION

Transfemoral amputees show an asymmetric gait pattern. However, some studies have found the microprocessor controlled knee prosthesis C-leg to improve gait symmetry [1,2,3]. This study hypothesized that C-leg improves gait symmetry compared to gait with the hydraulic knee prosthesis 3R60. Four measures of gait symmetry was investigated: 1) spatial symmetry, 2) temporal symmetry, 3) length of single support, and 4) comparison of butterfly plots.

METHODS

Five unilateral transfemoral amputees who had C-leg as their daily prosthesis completed the entire study. Two gait analyses were performed on each subject with a one week acclimation period between the two tests. The first gait analysis was performed on C-leg, and the second test was performed on 3R60. Five successful trials from both analyses were used for the statistical analysis.

Walking speed was controlled to be 1.1 *m/s*. Vicon 460 was used to collect kinetics and kinematics. Kinetics was measured by two force platforms with a sampling frequency of 1000 *Hz*. 15 reflective markers were placed on each subject, and the 3D positions were collected with a sampling frequency of 100 *Hz*.

The modified Helen Hayes' marker setup was used, and kinematic data was filtered by the quintic spline algorithm. The model did not include changed properties due to the prosthesis.

RESULTS AND DISCUSSION

Spatial symmetry was not significantly different between the two conditions (Table 1), but step length was longer on the prosthetic side than on the sound side. Temporal symmetry was better when using C-leg, but the difference between the two conditions was not statistically significant (Table 1).

Single support was considerably longer on the sound side than on the prosthetic side, but no difference was observed between the two conditions (Table 1). However, the subjects were able to reduce single support on the sound side and increase single support on the prosthetic side when they used C-leg.

Butterfly plots were generally narrower on the prosthetic side than on the sound side. The GRF vector at toe-off was often more forward oriented on the sound side than on the prosthetic side which indicates that some amputees rely heavily on the sound leg to generate propulsive forces (Figure 1). However, the patterns of the butterfly plots differed remarkably between subjects.

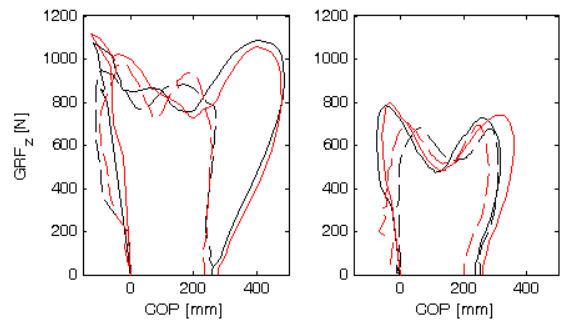

Figure 1: Butterfly plots of the sound and the prosthetic side of two subjects (left and right). Black lines indicate 3R60, red lines indicate C-leg, solid lines indicate the sound side, and dotted lines indicate the prosthetic limb. **Left:** Asymmetric gait pattern. **Right:** Symmetric gait pattern.

CONCLUSIONS

No significant differences were observed between C-leg and 3R60 prosthetic knees for any of the investigated variables. Thus, it cannot be concluded that C-leg improves gait symmetry, but temporal symmetry and single support indicated a tendency towards improved symmetry when subjects used C-leg.

REFERENCES

1. Segal AD, et al., *J Rehabil Res Dev*. **77**: 1209-1214, 2006.
2. Kaufman KR, et al., *Gait Posture*. **26**: 116-121, 2007.
3. Nimmervoll R, et al., *Orthopädie-Technik*. **54**: 562-565, 2003.

Table 1: Mean values ± one standard deviation. *p*-values were corrected by the use of a Bonferonni-Holm correction.

Variable	C-leg	3R60	*p* value
Spatial symmetry	-9.6 ± 8.8	-9.2 ± 10.8	0.96
Temporal symmetry	8.4 ± 1.8	11.8 ± 3.9	0.10
Single support (sound side)	39.7 ± 1.5	41.0 ± 0.9	0.14
Single support (prosthetic side)	34.6 ± 1.8	33.9 ± 2.1	0.46