

## C-LEG KNEES DO NOT IMPROVE STANCE PHASE KNEE FLEXION OR WALKING EFFICIENCY IN OLDER TRANSFEMORAL AMPUTEES

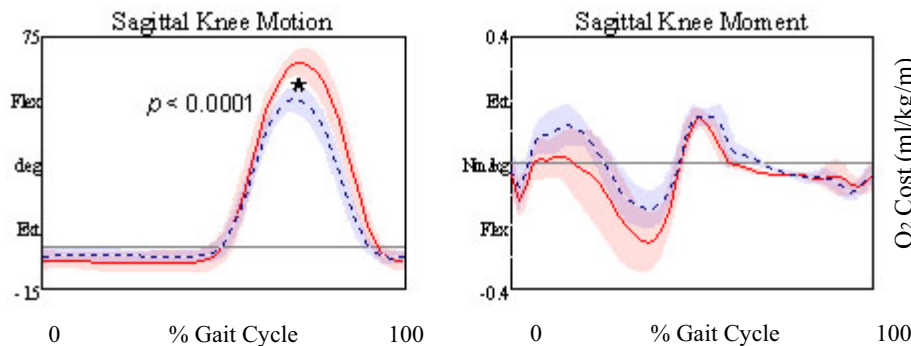
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### INTRODUCTION

Microprocessor-controlled prosthetic knees are hypothesized to improve stance phase knee flexion, sagittal knee moments and walking efficiency for transfemoral amputees. Few rigorous examinations of the kinematic, kinetic and energetic<sup>1</sup> improvements in transfemoral amputee gait have been published in peer-reviewed journals. The goal of this study was to compare the differences between the C-Leg (Otto Bock, Minneapolis, MN) and Mauch knees in stance phase knee flexion, knee extensor moment and gait efficiency across walking speeds in older, experienced transfemoral amputees.

### METHODS

Eight traumatic transfemoral amputees (age  $48.5 \pm 13.2$  years; Ht  $172.5 \pm 4.2$  cm; Wt  $80.1 \pm 10.5$  kg) gave informed consent to participate in this IRB approved protocol. Subjects were all previous long term Mauch swing and stance (SNS) users. Each subject was evaluated following a 3-month acclimation period in the C-leg and the Mauch SNS prosthetic knees with identical sockets; order of knee type was randomly assigned. Full body gait kinematics and kinetics were collected at each subject's self-selected walking speed (SSWS) using a 10-camera Vicon 612 system and Plug in Gait (Lake Forest, CA.). Peak knee flexion in single limb stance, peak knee flexion in swing and peak knee extensor moment in early stance was extracted using Event Analyser (Vaquinta Software, Southampton, UK). Later, oxygen consumption (ml/kg/min) was measured at 0.8, 1.0, 1.3 m/s and SSWS overground with a Sensormedics VmaxST mobile metabolic system (Loma Linda, CA) with seated rest between speeds. Oxygen consumption was converted to net oxygen cost (ml/kg/m) by subtracting resting levels and dividing by walking speed to estimate gait efficiency. Overground speed was enforced using a velocity-detecting cart pushed parallel to the subject by an investigator. Oxygen data was monitored in real time and the trial continued until 2 minutes of steady state metabolic data was collected, usually within 8 minutes. Knee flexion in stance and swing, knee extensor moment in early stance, and oxygen cost for the C-Leg versus the Mauch SNS were compared using repeated measures mixed effects ANOVAs.



**Figure 1:** Sagittal prosthetic knee motion, moment across the gait cycle for the C-Leg (dashed blue line) and the Mauch SNS (solid red line). Shaded area is  $\pm$  1SD.

### RESULTS AND DISCUSSION

There was no significant difference observed between stance phase knee flexion with the C-Leg or Mauch SNS knee; both knees remained in full extension through terminal stance phase. The C-Leg had lower (more normal) peak knee flexion during swing phase compared to the Mauch SNS ( $54.2 \pm 4.2$  vs.  $59.1 \pm 8.1$ ;  $p < 0.0001$ ). The peak knee extensor moment in early stance showed no significant difference between the knee types ( $p < 0.59$ ), although the moment was shifted slightly toward extensor (closer to normal) in the C-Leg knee. Oxygen costs at each of the 4 walking speeds were not statistically different with the C-Leg compared to Mauch SNS knee ( $p > 0.19$ ), indicating that the subject's gait was not more efficient with the C-Leg. This is consistent with previous literature<sup>1</sup>.

### CONCLUSIONS

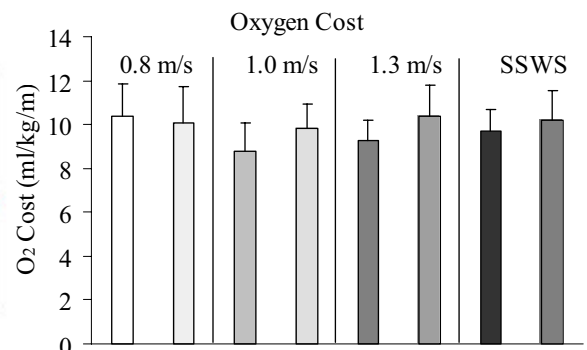
Older, experienced transfemoral amputees did not demonstrate significant improvements with the C-Leg despite a 3-month acclimation period. Even with the long acclimation period, these subjects were not able to take advantage of the eccentric knee flexion feature during early stance phase. This may be related to the subjects' previous long-term use of a Mauch SNS limb. Many subjects commented that they still found it difficult to break the habit of providing extensor force to the prosthetic limb in stance phase. Subjects described the C-Leg as having better stumble recovery and therefore fall prevention, although this was not explicitly measured in this study. Despite the lack of significant improvements observed in the kinematics, kinetics or energetics, 7 of the 8 subjects chose to keep the C-leg as their primary limb after the study was completed.

### REFERENCES

1. Buckley, JG, et al. *Arch Phys Med Rehabil* 78: 330-3, 1997.

### ACKNOWLEDGEMENTS

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**Figure 2:** O<sub>2</sub> cost for the C-Leg (solid) and Mauch (hatched bars) across 4 gait speeds. (Mean + 1SD)