

OBSTACLE COURSE PERFORMANCE: COMPARISON OF THE C-LEG TO TWO CONVENTIONAL KNEES

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INTRODUCTION

Previous investigations of some microprocessor-controlled (MC) knee joints have produced conflicting results, indicating clear benefits for amputees while others suggested there were no differences compared to conventional knee mechanisms [1-4]. Further quantitative analyses are needed to determine if it is beneficial to prescribe expensive MC knee mechanisms over passive knee units that cost significantly less.

The specific objectives of this study were to: (1) examine participants' walking performances while walking over an obstacle course (OC), and (2) test the influence of mental loading (ML) while walking over the OC using three different knee units.

METHODS

General: In a crossover study design, participants wore each prosthetic knee joint—Otto Bock C-leg, Otto Bock 3R60 and Mauch SNS—for a period of four weeks. Test prostheses were fabricated using a duplication of the participant's current prosthetic socket and each participant was fitted with a Dynamic Plus foot to reduce variability. **Participants:** Persons with unilateral transfemoral amputation, aged between 40 and 60 years, with a body-weight less than 125 kg, were included if they: presented with no serious complications that interfered with their walking ability; had six or more months of experience with a definitive prosthesis; and were able to walk unassisted at a comfortable speed without undue fatigue and without health risk. **Protocol:** The OC was set up in the VA Chicago Motion Analysis Research Laboratory. It consisted of a foam section (3m long, 1m wide (3x1), 20 durometer on a shore A scale), narrow slaloms around three chairs, a vacuumized bean-bag section (3x1) simulating sand, a rock section (3x1), a short downward sloping ramp (1.5x1.4), a 90-degree left turn, and a final stair step (height: 12cm). The ML test consisted of an arithmetic calculation task where the participant had to count aloud backwards in 3-step increments (1st visit), in 7-step increments (2nd visit) and in 3-step increments (3rd visit). Participants completed the OC twice, once without and once with ML. No familiarization run was allowed. Time was measured from a videotape recording of participants navigating the OC. **Statistical Analysis:** Friedman Test assessed the overall performance of the three knee joints. If a variable reached significance level, Wilcoxon Signed Rank Test was used to determine differences between each knee joint. A Bonferroni correction was applied to account for multiple testing, lowering the significance level to 0.016.

RESULTS

Data from 2 women and 9 men were analyzed. Their mean age was 45.8 ± 9.5 years, mean height was 175 ± 9 cm, and mean weight was 81.8 ± 14.1 kg. They were all established walkers with their amputation having occurred 20.1 ± 14.2 years ago.

The median time taken to complete the OS with the 3R60 knee was 34.9 seconds (s). Adding the ML altered the time minimally: 34.2s. For the C-leg, the total time without ML (32.1s) was slightly lower when compared to the 3R60 knee but increased with ML to 33.9s. The difference between the 3R60 and the C-leg was non-significant for both conditions (without ML: $p=0.169$; with ML: $p=0.045$). Participants performed best on the OC when fitted with the SNS unit: total median time without ML was 30.9s, with ML 32s. The difference between the SNS and the 3R60 was significant for both conditions. However, the difference between the C-leg and the SNS knee joint was not significant (without ML: $p=0.674$; with ML $p=0.678$) (Figure 1).

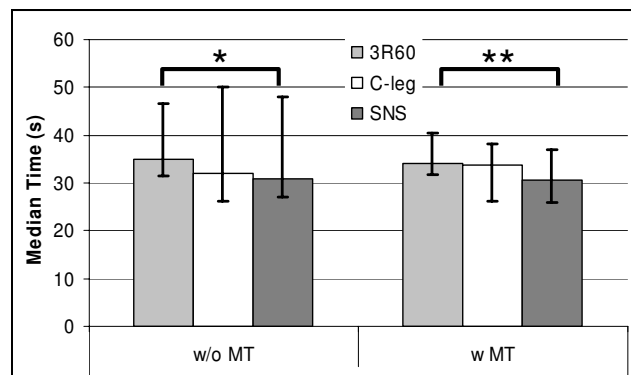


Figure 1: Total time taken (in sec) to complete the obstacle course for each prosthetic knee joint. w/o MT: without Mental Task * SNS-3R60: $p=0.011$ w MT: with Mental Task ** SNS-3R60: $p=0.005$

DISCUSSION AND CONCLUSIONS

The participants completed the OC in the shortest time when fitted with the SNS unit, followed by the C-leg, and they were slowest with the 3R60 knee regardless if ML was administered or not. The more mechanically complex (3R60) and the more sophisticated (C-leg) knee joints performed less favorably in this context. These two knees may require more time and training to take full advantage of their characteristics than the given 4-week accommodation period. However, it could also mean that for soft or uneven walking surfaces, a simpler knee (like a SNS unit) simply performs better, as participants may have a quicker and direct impact on its behavior.

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