INTRODUCTION
The C-leg® is an advanced microprocessor-regulated knee mechanism. It is thought to enhance function in a wide range of locomotion modes due to the stance and swing phase monitored gait cycle. It has been suggested that the C-leg® improves the amputee’s ability to walk down ramps and descend stairs (Stinus, 2000; Michael, 1999; Dietl, 1998; Zahedi et al., 1998). In this study the C-leg is compared with the 3R60 knee joint.

METHOD
General: Each participant wore each prosthetic knee joint for a period of four weeks. Test prostheses were fabricated using a duplication of the participant’s current prosthetic socket and a Dynamic Plus foot. Participants: Persons with unilateral transfemoral amputation, ages between 40 and 60 years, with a body-weight less than 220 lbs, were included in the study if they presented with no serious complications that interfered with their walking ability; had six or more months of experience with a definitive prosthesis; were able to walk unassisted at a comfortable speed without undue fatigue and without health risk; and were able to climb stairs. Protocol: Quantitative gait analysis was performed at the VA Chicago Motion Analysis Research Laboratory (VACMARL). Participants were requested to walk at their preferred and fastest speed, with and without mental loading. The mental loading test consisted of a mathematical calculation task where the participant had to count vocally backwards in three-step increments (first visit) and in 7-step increments (second visit). An obstacle course was set up at VACMARL being composed of a foam session (10 feet), narrow slaloms around three chairs, a vacuumized bean-bag section (10 feet) simulating sand, a rock section (10 feet), a short ramp (5 feet), a 90-degree turn, and a final step. Participants completed the obstacle course twice, once without mental loading, once with mental loading. They were timed. The stair task included one-flight with 10 steps; participants were requested to climb up and down the stairs in their usual manner, once without mental loading, once with mental loading. Heart rate was measured during all conditions in order to calculate the Total Heart Rate Index (THBI) (Hood et al., 2002). The THBI is calculated by dividing total heartbeats during an exercise period by the total distance traveled and is an indicator of energy efficiency. All of the participants gave written consent approved by the Institutional Review Board of Northwestern University.

RESULTS AND DISCUSSION
To date, data of three participants have been analyzed. The participants’ characteristics are shown in Table 1. Table 2 presents their walking speeds on level walking with and without mental loading. Due to the small number of participants analyzed, statistical tests have not been carried out. When comparing the two knee joints the mental task had a negative impact on all walking speeds in all participants while wearing the
3R60 joint; with the C-leg®, two participants increased their fast walking speed under the mental loading condition, one also at normal speed. In Table 3 the results of the THBI are summarized. Better energy efficiency, as indicated by the THBI, was achieved by the C-leg® only during normal walking speed without mental loading. In all other conditions, the energy efficiency was the same or worse with the 3R60 knee.

The C-leg® demonstrated the tendency to facilitate fast walking speed, especially under the mental loading condition. This suggests that once the participants’ main focus was not on walking, the C-leg® increased their confidence, so that they were able to walk faster with almost the same energy efficiency as with the 3R60 knee joint. However, in almost all other conditions energy efficiency was worse with the C-leg®, especially during the obstacle course and on the stairs. Under the mental loading condition, the C-leg® did not demonstrate energy efficiency improvement, like the 3R60 knee joint. The overall performance on the stairs was the same with both knee joints; thus performance change cannot explain the C-leg®’s THBI difference during stair negotiating. The THBI results stand in contrast with the results of Buckley et al. (1997) who observed reductions in the physical energy cost using an “Intelligent Prosthesis” (IP) from Blatchford. But our results regarding the mental loading are in support with the results of Heller et al. (2000) who also demonstrated that the IP was not shown to be less cognitively demanding than a conventional knee joint.

**SUMMARY**

In the given circumstances, the C-leg® seemed to produce mixed results. It tends to facilitate fast walking speed, especially under a mental loading task. However, the C-leg® energy efficiency, as estimated by the THBI, is generally worse than that of the 3R60 knee.

**REFERENCES**

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