INTRODUCTION
The gait of a unilateral lower limb amputee is asymmetrical (Jaegers et al., 1995). The altered load distribution leads to degenerative changes (Burke et al., 1978, Kulkarni et al., 1998). These degenerative changes can limit tasks and lead to a reduction in the quality of life. This study compared the gait symmetry of active transfemoral amputees while using a passive mechanical knee joint (NMPK) or a microprocessor-controlled knee (MPK) joint.

METHOD
Subjects: The study cohort consisted of 15 subjects (12 men, 3 women; age 42 ± 9) who had a unilateral above-knee amputation and were experienced prosthesis users (20 ± 10 years). They were tested with a mechanical stance-and-swing fluid-controlled prosthesis (NMPK) and retested with a MPK (Otto Bock C-Leg) after an acclimation period (18 ± 8 weeks). For comparison, 20 able-bodied subjects (9 men, 11 women, age 30 ± 8) were also studied.

Procedures: The study used a repeated-measures design where only the prosthetic knee was changed. Gait data were acquired with a computerized video motion analysis system and four force plates. A commercial software program (OrthoTrak 5.0, Motion Analysis Corp., Santa Rosa, CA) was used to calculate 3D kinematics and kinetics.

Data Analysis: A symmetry index (SI) was calculated over the entire gait cycle as the ratio between the variance about the eigenvector to the variance along the eigenvector created from the gait data. A symmetry index of +1 indicated perfect symmetry and -1 indicated perfect asymmetry. A two-way repeated measures ANOVA (2 gait phases × 2 knees) was used to determine whether the subject’s gait symmetry changed when wearing the different prosthetic knees. Statistical significance was set at p=0.05.

RESULTS
The kinematic symmetry differed by joint level and gait phase. There was no significant difference in hip, knee, or ankle kinematic symmetry when the subjects wore either of the two knee prostheses. The kinematic symmetry indices of the control subjects were >0.99 for all lower extremity joints.

There was a significant improvement in kinetic symmetry at the hip, knee, and ankle after receiving the MPK. The joint kinetics exhibited a symmetrical behavior for all joints (symmetry index ≈1) except for the knee in stance phase (Figure 1). The hip moment symmetry was significantly higher in stance than in swing. In contrast, the amputee’s knee and ankle moments were more significantly more symmetrical during swing that during stance. For comparison, the kinetic symmetry indices of the control subjects were >0.99 for all lower extremity joints.

DISCUSSION
Previous studies have shown that amputees have asymmetrical gait (Jaegers et al., 1995, Nolan et al., 2003, Engsberg et al., 1993, Schmid et al., 2005), which results in increased loading of the intact leg (Suzuki, 1972). Compensatory mechanisms lead to increased musculoskeletal disorders (Burke et al., 1978, Kulkarni et al., 1998, Norvell et al., 2005). The results of this study and a companion study (Kaufman et al., 2007) demonstrate that use of a MPK will result in improved gait and balance. These improvements should lead to reduced degenerative changes.

CONCLUSION
A MPK results in significantly improved gait kinetic symmetry for unilateral transfemoral amputees.

REFERENCES

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