INTRODUCTION

Mechanical prosthetic knees produce no moment during standing. Sitting and microprocessor knees’ effect on transfemoral amputees’ sit and stand ability have not been studied. This cross-sectional study reports the kinetic asymmetry of community ambulatory TFA’s of varied etiology, performing sitting and standing using a Power Knee, C-Leg, or Mauch SNS.

METHOD

Subjects: USF IRB approved the protocol. 28 subjects provided consent. TFA’s were unilaterally involved and had no prosthetic adjustments for <90 days. TFAs’ mean age (n=21): 46±16yrs, height: 178±9cm, mass: 83±15kg. There were 7 each using the Power Knee, C-Leg and Mauch SNS. Controls (n=7) were non-amputee college students; mean age: 24.6±4yrs, height: 174±7cm, mass: 69±13kg.

Apparatus: 3D Motion Analysis, 2 Force Plates, adjustable height seat.

Procedures: Subjects stood from and sat to a platform set to a seated 90±5º knee angle without using hands. Subjects completed 3 trials of both movements.

Data Analysis

Ground reaction forces (GRF) were determined from force plates and a 2D kinematic model determined bilateral joint angles, forces and moments of the hip and knee sagittally.

Peak values were extracted and normalized. Event durations were also recorded.

Degree of asymmetry (DoA) was calculated via:

$$\text{DoA} = \frac{(S-P)}{(S+P)} \times 100$$

S and P indicate sound/dominant and prosthetic sides respectively, of GRF, knee or hip moment. A +DoA represents sound side asymmetry, a -DoA prosthetic side and ‘0’ is perfect symmetry.

Statistical Analysis

A one-way ANOVA was used (SPSS17) to determine if statistical differences existed among means between group and sides (for DoA). Levene’s homogeneity-of-variance test was used to test for normality. Bonferroni’s post-hoc test was used when variance was equal otherwise, Tamhane’s T2 test was used. Significance was p<.05.

RESULTS & DISCUSSION

Duration: Stand times ranged: 1.6-2.0s with Mauch and C-Leg knees most delayed. TFA stand times are similar to controls. Sitting takes longer than standing: 1.6-2.0s and C-Leg users took the longest time possibly due to subjects’ functional level and etiology.

Ground Reaction Forces: Controls’ GRF is symmetric while standing. TFA causes GRF asymmetry. Prosthetic loads may reach 52% but typically, 20% is applied to mechanical prostheses. Mauch users had 6% DoA, different from all prosthetic users. Mauch users put greater load on the sound side compared with the Power Knee and controls. GRF DoA was highest with Mauch users 60%, followed by C-Leg (53%) and Power Knee (32%).

Figure 1. Kinetic variable group means as % asymmetry. Significant differences denoted as A- different from all prostheses, P- Power Knee, C- C-Leg and M-Mauch knee.

Joint Moments: In standing, controls’ joint moments (DoA) were: knee -3% & hip 21%. TFA’s group mean sound side knee moments were higher than controls’. All prostheses resisted standing and Power Knee’s extension assist engaged after standing’s kinetic peak demands. TFA’s are more symmetric in hip than knee moment while standing and all TFA’s produced hip moments contributing to standing.

Controls’ sitting knee moments were 3% dominant-side asymmetric and TFAs’ were: 87-114%. The claim: progressive resistive prosthetic knees produce a moment to assist sitting is overstated. The resistive magnitude observed here was beneficial in a minority of subjects. Sitting hip moments were all dominant-side asymmetric.

CONCLUSION

TFA’s sit and stand at rates similar to controls and do not load the prosthesis extensively during the tasks. Power Knee did not assist standing but enhanced sitting symmetry. Though differences between knees were not significant, they may be clinically significant individually.

REFERENCES