THE EFFECT OF PROSTHETIC FEET ON BOATS
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INTRODUCTION
Sailing is a feasible but under-rated hobby for lower limb amputees and disabled individuals who wish to sail recreationally and professionally. Promoting sailing can help address problems of reduced physical activity in this population. The boats used for adaptive sailing are reduced to a small cockpit for the individual with many pedals, switches and levers to allow full control of the vessel while remaining seated and stationary. Use of larger or non-modified vessels, however, remains challenging.

Mobility and balance aboard boats is of great importance for operating and maintaining a boat. [1] Having a prosthetic foot with the greatest ability to move about and balance while boating is crucial for the safety and comfort of an amputee on the water. [2] On a boat, demand for balancing in the A-P and M-L directions is dramatically increased compared to on normal ground. Therefore, a prosthetic foot that is more effective for an individual on normal ground for gait and balance may not be as effective as another prosthetic foot aboard a boat, such as a peg-leg.

This study is exploratory and focuses on boats, which have not been adapted for an individual, in order to further open up sailing as a feasible activity for persons with lower limb loss. The aim is to compare center of mass (COM) displacement in unilateral trans-tibial amputees when using a peg leg (or peg-leg substitute) with other prosthetic foot options aboard a boat.

It was hypothesized that the Peg-Leg foot provides a more stable standing and balancing on an ocean vessel compared to the person’s regular prosthetic foot.

METHOD
Subjects: Person with trans-tibial limb loss, who were using a modular prostheses for ambulation were recruited for this pilot study.
Apparatus: A questionnaire assessing the experience of subjects as it relates to boating was administered. COM displacements were recorded using an iPecs mobile gait lab (RTC Electronics, Frazer, MI). Data collection took place on a 24-foot boat moored on a local river.

Procedures: The subject’s prosthesis was modified by installing the iPecs module into the existing structure. The existing foot was replaced by a rubber stomper foot (Stomper Products, SPS) for part of the data collection. The subject was asked to stand still for one minute once on solid ground and once on the boat. The procedure was repeated after feet were changed.

Data Analysis: The continuously collected horizontal ground reaction force data were plotted and interpreted using Excel (Microsoft, Redmond, WA). The total length of the plotted trajectory of the horizontal ground reaction vector over the one minute intervals was computed and used for comparison.

Statistical Test: A 2x2 ANOVA was conducted to compare main effects between feet and between standing surfaces, as well as the interaction effect.

RESULTS
Data of the first subject is presented here. The subject was a 54-year-old former member of the US NAVY, who underwent traumatic limb loss 18 years ago. His standard prosthesis consisted of a total surface bearing socket with liner suspension and an energy–storage-and-return foot.

The trajectory of the horizontal ground reaction force vector over the course of one-minute- standing trials was generally longer with the peg leg than the conventional foot (Figure 1).

DISCUSSION
The plotted data indicate a substantial difference in COM displacement when using different feet on a boat. The COM trajectory wearing the normal prosthetic foot was more concentrated and shorter in length than the COM trajectory while wearing the peg leg suggesting that a peg leg does not decrease the effect of boat motions on the COM trajectory relative to a normal prosthetic foot.

CONCLUSION
A regular prosthetic foot may have advantages over a peg leg device when used for ambulation and balance on boats.

CLINICAL APPLICATIONS
Use of dedicated prosthetic feet can have effects on the standing and walking stability of persons with limb prostheses on boats. In order to facilitate the safe engagement in boating as a health leisure activity, foot selection should be carefully considered.

REFERENCES