ASSESSMENT OF ROLL-OVER SHAPE TESTING AS A DESIGN TOOL FOR IMPROVED PROSTHETIC FEET IN THE DEVELOPING WORLD

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INTRODUCTION

A survey of the literature and commercially available prosthetic components appears to indicate a prevailing philosophy in the prosthetics community that proper interfacing of high quality prosthetic components, which are functionally sound in their own right, will result in desirable human functionality outcomes at the systems level. Since 2004, researchers with LeTourneau University's LEGS program have been seeking to develop an improved locally reproducible transfemoral prosthesis design with high levels of functionality for amputees in the developing world. As with any transfemoral prosthesis, the cornerstones to a successful device are the knee and foot components.

In developing an improved foot design it is essential that objective and quantitative data on component behaviour be obtainable to guide the engineering design work. While the evaluation of foot "energy return" characteristics has been advocated by several researchers (Hafner, 2002; Haideri, 2005), Hansen et al. (2002, 2000, 2004) have proposed an alternative method which quantifies the effective rocker characteristic of the foot during walking, between heel contact and opposite heel contact. This method, referred to as the Roll-over Shape Method, was used to compare the behaviour of 11 prosthetic feet used in the developing world (Sam, 2004a) and was used as the basis for a new low-cost foot design developed by Sam et al. (2004b). Though proposing a potentially beneficial comparison between prosthetic and biological feet, a survey of the literature indicated an absence of information on the robustness of the methodology and its resulting data. Furthermore, most reported studies using this method appear to originate from the same laboratory and currently limited inter-laboratory validation exists.

This paper reports initial findings of ongoing work to develop the roll-over shape methodology. The work aims to address two issues: (i) validation of test outcomes on an inter-laboratory basis, and (ii) further correlation between roll-over shapes and reported behaviour of various prosthetic feet.

METHOD

Eight prosthetic feet were tested: NWU Shape & Roll (patent pending), Jaipur, Otto Bock SACH, Kingsley SACH, Niagara Foot™, ICRC SACH, and Flex-Foot® Modular III. Feet were selected to provide an initial comparison of foot options for both the developed and developing worlds with several coinciding with feet previously tested by Sam et al. (2004a). Testing was conducted based on the earlier reported studies of Hansen et al. Direct consultation with Hansen was also used to ensure compliance between this study and previous ones.

RESULTS

Roll-over data of each foot was summarized, along with their radii of curvature, and each prosthetic foot compared to the biological foot. Results for the ICRC and Jaipur feet were found to be comparable to those obtained by Sam et al. (2004a). This inter-laboratory comparison validates the reproducibility of the Roll-over Method. Other prosthetic feet tested showed a correlation between their reported behaviour and roll-over shapes. Commonly known for its flexibility, the Jaipur foot had the smallest radius of curvature thus verifying its widely reported behaviour.

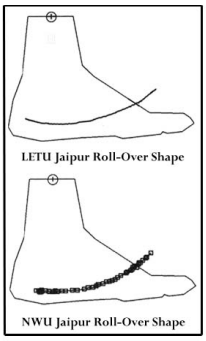

Figure 1. Comparison of Jaipur Roll-Over Shapes

DISCUSSION

Preliminary results show good correlation between the outcomes of the current study with previously reported studies and a strong relationship between reported behaviour and roll-over shapes. From the available data, it would appear that while test outcomes are able to be replicated between different sites, there may be a need to more closely define the test methodology to minimize operator influences and ensure reliable data.

CONCLUSION

Roll-over shape testing allows for a quantitative method by which to compare prosthetic feet to a biological foot. As a result of this study, we believe the roll-over shape method is valid for assessing new foot technology in our quest to design an appropriate prosthetic foot for the developing world.

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