ROLL-OVER SHAPES OF PROSTHETIC FEET COMMONLY USED IN DEVELOPING NATIONS

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Lower-limb amputees are most effectively rehabilitated by restoring lower-limb function to the highest degree of comfort and mobility possible (Klute, et. al., 2001). LeTourneau Engineering Global Solutions' (LEGS) goal is to achieve these requirements with our prosthetic design for developing nations. As part of a larger effort, we quantified the roll-over shape of six prosthetic feet commonly used in third-world countries. Roll-over shape allows for the comparison of the prosthetic feet to the roll-over shape of a biological foot by measuring the location of the center-of-pressure of the foot with respect to a fixed axis between the ankle and knee in the saggital plane (Hansen, et. al., 2000). Six prosthetic feet were tested: Northwestern University's Shape & Roll Prosthetic Foot (patent pending), Jaipur, Solid Ankle Cushion Heal (SACH), Niagara Foot™, International Committee of the Red Cross (ICRC), and the first generation of our LEGS foot.

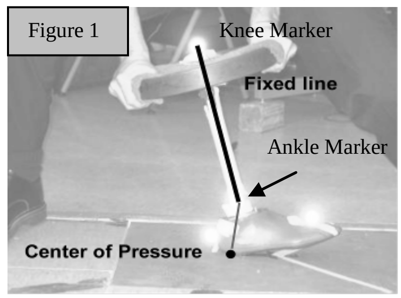

Figure 1

Testing utilized a motion capture system and a force plate. Data for each prosthetic foot was recorded while mounted to a quasi-static foot tester (Fig. 1) and manually "walked" by applying a uniform vertical force measured by a force plate while infrared cameras captured positional data from reflective markers placed on the simulated ankle and knee. For comparison, a subject was similarly fitted with reflective markers and walked across the force plate to record a biological foot roll-over shape and is acceptable contrast since there appears to be no appreciable difference between quasi-static or dynamic roll-over effects (Hansen, et. al., 2000).

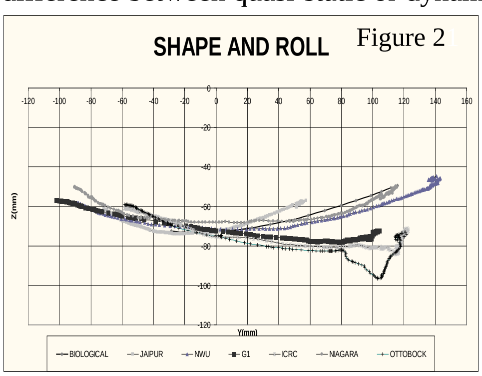

Figure 2

Changing center-of-pressure of each foot was plotted with respect to a fixed line (Fig. 1) established by the knee and ankle markers in the saggital plane to produce the distinctive roll-over shape. Roll-over data of each foot was summarized and each prosthetic foot compared to the biological foot. Figure 2 shows the roll-over shapes of the prosthetic feet compared to the biological foot. Radii of curvature of the roll-over shapes were also obtained for comparison. Compared with the biological foot radius of 420 mm, NWU was at 360 mm, Jaipur at 151 mm, SACH at 350 mm, Niagara at 300 mm, ICRC at 420 mm, and the LETU foot at 740 mm. Results showed varying levels of imitation between the biological and each prosthetic roll-over shape. We believe the deviation of the prosthetic feet from the biological foot ideal is often a result of stiffness, misalignment, and/or poor design.

Roll-over shape testing allows for a quantitative method in which to compare prosthetic feet to a biological foot. As a result of these tests, we believe we can use roll-over shape testing to develop a prosthetic foot that better mimics a biological foot thereby increasing comfort and mobility in the rehabilitation of lower-limb amputees in developing nations.

Klute G.K., Kallfeiz, C.F., Czerniecki, J.M., (2001). Mechanical properties of prosthetic limbs: Adapting to the patient. *Journal of Rehabilitation Research and Development*, 38(3), pp 299-307.

Hansen A. H., Childress D. S., Knox E. H., (2000). Prosthetic Foot Roll-over Shapes with Implications for Alignment of Trans-tibial Prostheses. *Prosthetics and Orthotics International*, Vol. 24, No. 3, December, 205-215.