Center of Excellence for Limb Loss Prevention and Prosthetic Engineering

Prosthetic Engineering Research

Dept. of Veteran Affairs Rehabilitation Research and Development (VA RR&D), Seattle, WA

Our aim is to improve prosthetic prescription by investigating the efficacy of prosthetic components used in current clinical practice and by developing novel approaches intended to improve the current standard of care. Our amputee-centric research encompasses improving mobility and patient comfort, preventing injury, and enhancing sensation. Support for this research (2000 to present) includes funding from VA RR&D through grants: A4376R, A3666I, A3611I, A3289R, A2661C, A2770I, and A2448R.

C-Leg

The Otto Bock C-Leg knee has deeply penetrated the amputee market, yet little is known about the efficacy of this expensive, computerized prosthesis. Our research found transfemoral amputees choose to walk faster with the C-Leg than with the conventional knee but at the same metabolic cost. There was no activity level difference between knees, no difference in fatigue or perceived exertion, and no difference in cognitive demand.

Turning Gait

Turning corners and maneuvering around obstacles are essential abilities for successful community and household ambulation. Our aims are to quantify maneuverability and stability, test the efficacy of a compliant torque adapter in the pylons of transtibial amputees, and to engineer improved interventions to enhance mobility and comfort.

Inversion / Eversion Ankle

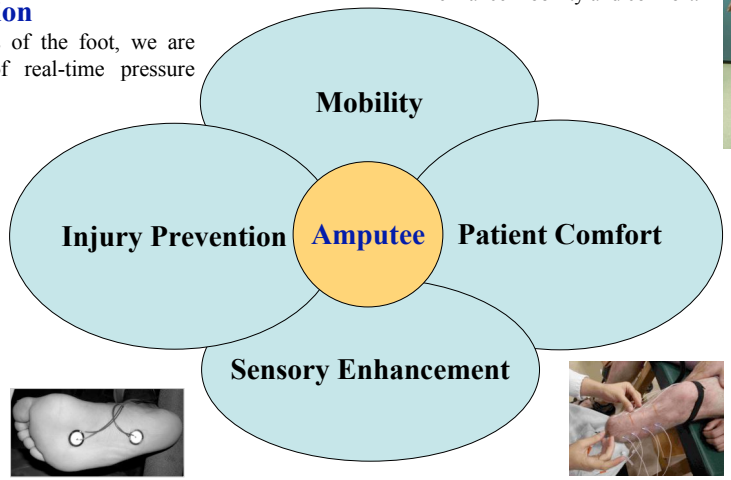
Errors in foot placement while avoiding obstacles and maneuvering in the household and community environments may lead to falls and injuries. This research aims to develop an ankle that can control the center of pressure under the prosthetic foot and enhance balance and stability.

Torsional Prosthesis

This research seeks to develop a prosthetic limb whose torsional characteristics can potentially be controlled with biological inputs such as implanted electromyographic sensors (Cleveland collaboration) and (or) environment-based input signals such as rate gyroscopes.

Controlled Plantar Pressure Redistribution

To minimize mechanical stresses in ulcer prone areas of the foot, we are developing an insole fabrication process capable of real-time pressure measurements and adaptive pressure redistribution.



Powered Prosthesis

Many ambulatory lower limb amputees exhibit fatigue, asymmetrical gait, and the inability to walk at varying speeds. We are developing and testing a powered prosthesis capable of providing propulsive forces necessary to alleviate these problems.

Residual Limb Skin Temperature

Lower limb amputations often experience discomfort related in part to higher skin temperatures within their prosthetic socket. Our research indicates that walking can cause a dramatic increase in skin temperature within the prosthesis and substantially long periods of inactivity are required to restore resting state temperatures. Measurements of liner and socket thermal conductivities indicate they are extremely effective insulators. Our current work is exploring environmental influences on skin temperatures.

Shock Absorption

Problems with the skin and soft tissue of the residual limb might be ameliorated by effective attenuation of the shock loads experienced during gait. Our research has shown that a commonly prescribed shock absorbing pylon is as effective as a rigid pylon, suggesting an opportunity for improvement. Our current research is exploring impact attenuation in prosthetic feet and liners.

Stochastic Resonance

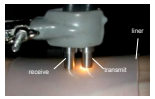
Stochastic resonance (sub-threshold vibration) may enhance peripheral sensation sufficiently to result in improved postural stability and locomotor function. This research explores application of this phenomenon to the residual limb and intact plantar surface of diabetic lower limb amputees.

Vacuum Socket

Many amputees live with an ill-fitting socket and can experience limb pistoning within the socket, which in turn may result in skin irritation, tissue breakdown, discomfort, and a reduction in activity. The aims of this research are to characterize the response of the lower residual limb to a vacuum suspension system and to measure its performance compared to a typical suction suspension.

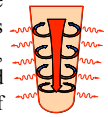
Tissue Oxygenation

For the dysvascular lower limb amputee, the choice of prosthetic socket and suspension system may influence the amount of oxygen present in residual limb tissues, a close correlate with limb health and wound healing capacity. Using our novel, fiber-optic video-oximetry imaging system, we aim to discover if prosthetic prescription can influence residual limb tissue oxygenation during both rest and gait.



Perception of Thermal Comfort

The aim of this research is to develop a thermally adaptive prosthesis employing thermal electric coolers and test its performance using measurements of skin temperature, blood flow (related to the vaso-regulatory response and coupled with perspiration onset), and patient perception of thermal comfort.



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