THESIS ABSTRACT

CLINICAL EVALUATION AND IMPROVEMENT OF PROSTHETIC SUSPENSION SYSTEMS FOR LOWER LIMB AMPUTEES

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ABSTRACT

The method of attachment of prosthesis to the residual limb (suspension system) is a critical issue in the process of providing prosthesis to an amputee. Proper fit of the stump inside the socket and appropriate selection of prosthetic suspension positively affect the amputees’ gait, distribution of pressure within the socket, and amputees’ satisfaction. This research aimed to: (1) conduct a survey to compare the effects of seal-in and common suction socket (CSS) on transfemoral amputees’ satisfaction; (2) compare the effects of the Seal-In liner and Dermo liner (Pin/lock) on transtibial amputees’ gait performance; and (3) design and evaluate (mechanical testing, pressure mapping, gait evaluation, and satisfaction survey) a new prosthetic suspension system. The survey study showed that overall satisfaction increased with the use of the Seal-In liner compared with the CSS (P<0.05). The transfemoral amputees also suffered fewer problems with the use of the Seal-In liner. Comparison of the effects of the Seal-In liner (suction) and Dermo liner (pin/lock) on transtibial amputees’ gait revealed much symmetry in temporal-spatial parameters between the prosthetic and sound limbs using the suction system. However, the two systems exhibited insignificant difference (P>0.05). Evaluation of kinetic data and subjects’ feedback showed that the participants were more confident to use the suction socket, and the sockets were more suitable for walking. However, the participants expressed more complaints with this system because of difficulty in donning and doffing. Factors influenced by the prosthetic suspension system were derived through an extensive systematic literature review, and a new suspension system (Holo) using Velcro or Hook and Loop concept was designed and fabricated. The universal testing machine was used to evaluate the mechanical properties of the designed suspension system. For validation, the Holo was compared with three other common suspension systems, namely, the pin/lock, seal-in, and magnetic suspension system.

CITATION


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KEYWORDS

Prosthetics, Rehabilitation, Amputee, Lower limb amputee, Silicon liner, Prosthetic socket, suction socket, discomfort, Transtibial, Below knee, Dermo liner, Seal-In liner, Tensile load, Gait evaluation, Interface pressure.

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The maximum tensile load that the new system could bear (before failure) was 490 N (SD, 5.5). However, the pin/lock system could tolerate loading of 580 N (SD, 8.5). The magnetic (MPSS) and seal-in (suction) could tolerate loads of 350.9 N (SD, 7.0) and 310 N (SD, 8.4), respectively. Comparison (interface pressure) between the pin/lock and the Holo system showed that high pressure was applied to the residual limb at the distal region of the stump by the pin/lock system during ambulation. The new coupling system could distribute the pressure more uniformly over the residual limb. PEQ results indicated that the participants were generally pleased with the new system, particularly with easy donning and doffing procedures. Gait evaluation (case study) demonstrated a slightly higher walking speed and stride length with the new socket with Velcro suspension system than with the pin/lock system. Kinetic results also revealed that the patient were more confident to walk with the Holo system. The Holo suspension system may be used as an alternative suspension system for lower-limb amputees because the biomechanical findings were consistent with the ranges in the literature.

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Hossein Gholizadeh is a Postdoctoral fellow at the Ottawa Hospital Research Institute (OHRI), University of Ottawa, with a focus on lower limb prosthetic suspension systems. He has sound clinical and academic background in Prosthetics and Orthotics, especially in amputee rehabilitation and lower limb prosthetic care for more than 18 years. He received his PhD in Biomedical Engineering from the University of Malaya, Malaysia, with a focus on designing and developing suspension systems for lower limb prostheses. He also served as a prosthetics lab instructor in the University of Malaya (2009-2014). Hossein graduated from Iran University of Medical Sciences with a BSc in Prosthetics and Orthotics followed by MEngSc in Biomedical Engineering from the University of Malaya. He has over 50 scientific publications and serves as a reviewer for several scientific journals.
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