DESIGN, DEVELOPMENT AND CLINICAL EVALUATION OF A NEW PROSTHETIC SUSPENSION SYSTEM FOR LOWER LIMB AMPUTEES

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ABSTRACT

BACKGROUND
Suspension systems have considerable effects on the amputee’s mobility, comfort, and satisfaction with prosthesis. Negative effects of poor suspension on rehabilitation, as well as the comfort and activity level of lower limb amputees, were previously stated.

OBJECTIVE(S)
This research aimed to develop a prosthetic suspension system and to explore the biomechanics of prosthesis that incorporates the new system for transtibial amputees.

METHODOLOGY
A prosthetic suspension system was designed, fabricated and tested based on the magnetic field. The system was equipped with an acoustic alarm system as an added safety feature: the safety alarm system would buzz a microcontroller unit if the suspension is going to fail. For validation, the MPSS was compared with two other common suspension systems.

FINDINGS
The MPSS and pin/lock caused comparable amounts of pistoning, whereas the least pistoning resulted from the Seal-In system. The findings indicate that the mean peak pressure (in kilopascal) was lower with the MPSS than with the pin/lock over the anterior and posterior aspects during one gait cycle (P < 0.05). Overall, the average peak pressure values were higher with the Seal-In system than the MPSS and the pin/lock system. The MPSS caused significantly different peak pressures at the anterior proximal region compared with the pin/lock (P = 0.022) and Seal-In (P = 0.001) during the stair ascent and descent, and ramp negotiation. Motion analysis showed that several kinetic and kinematic variables were affected by the suspension type.

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KEYWORDS
Prosthetics, Rehabilitation, Amputee, Lower limb amputee, Gait analysis, Motion analysis, Silicon liner, Prosthetic socket, Satisfaction, Pistoning, Kinetic, Kinematic, MPSS.
CONCLUSIONS
The MPSS may reduce the pain and discomfort at the distal residual limb by decreasing the pressure within the prosthetic socket in comparison to the pin/lock system during gait. Main significant effects of the suspension type were evident in the vertical and fore-aft ground reaction forces, knee, and ankle angles. The MPSS showed comparable effects in the remaining kinetic and kinematic gait parameters. Finally, satisfaction rates were significantly high with the MPSS, especially for donning and doffing, walking, uneven walking, and stair negotiation. The MPSS may be used as an alternative suspension system for lower limb amputees.

LAYMAN’S ABSTRACT
Individuals with lower limb amputation require a prosthesis for mobility. The prosthesis is suspended to the leg through several main components via a suspension system. This research was focused on developing a new suspension system with the aim to improve the current available suspension mechanisms. The system was both mechanically and clinically tested on amputees to explore its performance during activities of daily living. Subjective feedback of the users was also recorded and analysed.

AUTHOR SHORT SCIENTIFIC BIOGRAPHY
Arezoo Eshraghi is a prosthesis & orthosesist, and currently a Postdoctoral fellow at the Holland Bloorview Kids Rehabilitation Hospital, fully affiliated with the University of Toronto. Dr. Eshraghi has clinical, research and academic experience in the field of Prosthetics and Orthotics, including but not limited to amputee rehab and prosthetic care. She is a member of Scientific Committee of the International Society for Prosthetics & Orthotics for 2017-2019. With a good track record of scientific publications, she serves as reviewer for several journals in the field of prosthetics & orthotics, rehabilitation, and biomechanics. Dr. Eshraghi has been involved in several international and national research projects, many of which has been funded by world-renowned manufacturers of assistive technology, such as Ossur. Her work has led to few innovative prosthetic systems, commercialized and currently available in the global market.