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Comparative Effectiveness Research in Prosthetics and Amputee Rehabilitation at the University of South Florida Contemplating New Interventions for Contractures in Amputees

M. Jason Highsmith[1,2*]

[1]School of Physical Therapy & Rehabilitation Sciences, Morsani College of Medicine, University of South Florida, USA
[2]Center for Neuromusculoskeletal Research, Morsani College of Medicine, University of South Florida, USA

Abstract

An estimated 1.6M persons live with limb loss in the U.S. It is estimated that this population will double in the coming decades making it important to focus clinical research on improving function and quality of life for these people. The research team at the University of South Florida's School of Physical Therapy & Rehabilitation Sciences has been conducting comparative effectiveness research with this population since 2005. Projects have included topics from general daily function to extreme recreational and occupational pursuits. Specific device studies have been conducted as well as rehabilitation techniques. Recently, the historic challenge of restrictions of joint range of motion has emerged and problematically, management techniques have not kept pace with the development of prosthetic technology. This paper summarizes research conducted recently and recommends consideration of alternative approaches to joint restriction.

Keywords: Limb deficiency; Physical therapy; Rehabilitation; Transtibial; Transfemoral

There are an estimated 1.6M persons in the U.S. living with loss of a limb. This number is estimated to nearly double by the year 2050 largely due to chronic disease processes [1]. Rehabilitation of the person with amputation lacks a strong evidentiary basis, clinical practice guidelines and treatment algorithms. For these reasons, much additional research is needed to better understand how to manage the rehabilitation for persons with amputation and which interventions best restore function.

Since 2005, University of South Florida's (USF) School of Physical Therapy & Rehabilitation Sciences' researchers have been conducting comparative effectiveness studies for both prosthetic interventions and rehabilitation strategies for persons living with limb loss. Key areas of interest here have been in determining comparative effectiveness of several microprocessor knee systems for persons with above-knee amputation [2,3]. In some cases, this research has been source material for documents that guide reimbursement policy [4]. Additional areas of study at the USF Human Functional Performance Laboratory have been in the areas of extreme performance and athletics that are difficult to study in a laboratory setting. For instance, researchers investigated optimal prosthetic configurations for rock climbing (Figure 1A) with a transfemoral amputation at a time when newer U.S. military treatment facilities were being constructed and incorporating rock climbing as part of their rehabilitation offerings [5]. Further, the feasibility of kayaking (Figure 1B) with hand amputation was studied when extreme athletic competitions held in the community were observed to have no competitors with amputation of the upper extremity [6,7]. Since then, further studies of prosthetic prehensor systems have been undertaken. In a second recreational example, the team studied two terminal devices relative to performance in golfing (Figure 1C). In a more general example of daily function for persons with transradial amputation, a study comparing voluntary -opening versus -closing control strategies with multi-functional, body-powered prehensors is underway.

Figure 1: A. USF Team working with staff from Vertical Ventures to conduct the USF Rock Climbing Study.
B. Training a volunteer in the use of the USF Kayak Hand.
C. Highsmith working with volunteer in a project comparing terminal devices for golfing.
D. Dr.'s Mengelkoch and Highsmith working with a volunteer conducting a study of amputee running efficiency.

Most recently, the USF prosthetic research team is studying the performance of tactical athletes who have predominantly sustained combat-related unilateral transtibial amputation. The study is evaluating the person with transtibial amputation's ability to perform in a rigorous

***Corresponding author:** M Jason Highsmith, PhD, DPT, CP, FAAOP, School of Physical Therapy & Rehabilitation Sciences, Morsani College of Medicine, University of South Florida, 12901 Bruce B. Downs Blvd. MDC077, Tampa, FL33612, USA, Tel: (813)974-3806; Fax: (813) 974-8915; E-mail: mhighsmi@health.usf.edu

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field environment utilizing different prosthetic feet. Results of this study should provide some insight into the magnitude of impairment with this level of amputation compared to a non-amputee control group. This Department of Defense sponsored project follows a preliminary treadmill study comparing bioenergetic efficiency of multi-functional prosthetic feet with specialty running feet (Figure 1D).

Perplexingly, it is common clinical knowledge that the person with amputation is likely to have range of motion limitations and possibly even joint contracture(s). Recently, we identified a mean (SD) hip flexion contracture of 12.8 ± 7.7° in a sample of 20 community ambulating persons with transfemoral amputation. Such a finding in independent, high functioning prosthetic users could suggest that contractures in those with variable levels of dependency and less functional capacity may have far more severe contractures. This could greatly limit comfort, prosthetic use, function and ultimately quality of life. Some literature clearly identifies that minimizing joint contractures are important within a list of factors contributory to the ultimate prognosis of the person with lower extremity limb loss [8]. Problematically, there are few studies to guide practice in the area of contractures. There are the fundamental low load, prolonged stretch [9] and contract-relax manual techniques [10] for instance that have been a part of physical therapy practice for many years however, efficacy data in the amputee population is sparse.

Recently our team re-evaluated a gentleman with transfemoral amputation who expressed great satisfaction and comfort with his newly aligned prosthesis that was set in greater pre-flexion for his hip flexion contracture. Such accommodation has been routine for decades [11] and other prosthetic accommodations are still described in more recent literature but routinely in case study format [12]. During assessment of this particular patient's stair gait, he struggled to activate the knee damping feature of his prosthesis for stair descent. Consider the likely possibility that rather than encouraging therapeutic stretching interventions, the decision was made to accommodate the contracture prosthetically and thus, the contracture is now beginning to compromise gait function in complex and difficult environments such as stairs. Further work is needed to understand how far the confounding effects of joint contractures reach into the patient's functional ability. Moreover, much more work is needed to determine how much prosthetic accommodation is needed and should be balanced with therapeutic stretching interventions. Within stretching interventions, the particular mode and parameters also remain largely unexplored when it comes to application in those with lower limb loss. Given that this editorial is in the Journal of Yoga and Physical Therapy, it would be remiss not to point out that the success of Yoga intervention in the management of the amputee population is also lacking. Maintaining sustained positions inclusive of balance and weight bearing offer many challenges that the amputee may benefit from however some have expressed concern about the ability to perform them with their prosthesis. Anecdotally, others have offered that the support of an aquatic environment has enabled participation in such activities. We believe there is potential merit in these approaches. We look forward to the building of this body of knowledge by the rehabilitation science community and at times have to remind ourselves that a high-tech, low-touch approach is not necessarily always the proper approach. The patient, their function and quality of life has to come first and thus our willingness to consider all perspectives and approaches has to be as flexible as we would like for our patients' joints to be.

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Disclosures

The author is solely responsible for the content of this article and declares no conflict of interest.

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