Volume Management with a Twist

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INTRODUCTION

Regardless of etiology or level of amputation the residual limb undergoes substantial change in shape and volume up to 18 months after amputation with continued fluctuation throughout the lifetime of the amputee (Sanders, 2011). Constant and continual changes in residual limb shape and volume lead to problems in creating and maintaining an accurate fit of a prosthetic socket necessary for skin protection and maximal functional control of the prosthesis. Nearly 2 million persons are living with the limb loss in the United States (Zeigler-Graham, 2008). Most amputees utilize socks and/or have multiple adjustments or replacement sockets in order to maintain fit and function

METHOD

A systematic review of measurement and management of residual limb volume change by Sanders and Fatone (2011) verified the presence of significant volume and shape change of the residual limb within the first 18 months post amputation and continued changes within the mature residual limb. This review also reported designs and challenges to accommodate volume changes with adjustable sockets utilizing adjustable bladders or strap tension.

Traditional solutions for accommodating volume change address the problem with a residuum global solution or a more localized solution. The patient can vary the global volume of the residual limb by either adding or removing sock ply. This method requires removing the socket to adjust sock ply, Zachariah et al (2004) reported that when the socket is removed residuum volume increases up to 11% typically within the first 8 minutes after socket removal, thereby creating variation and unpredictability in volume management. This method does not address localized volume changes within the residuum and could cause excessive pressure over tissue that has not changed, such as tissue over bony prominences. Other solutions involve the modification of the in-socket shape and volume by selectively adding padding. The method of adding padding may more appropriately address regional volume or shape changes however the padding may compress over time and does not accommodate diurnal changes. When the residual limb has had significant change that cannot be accommodated a new socket is manufactured.

Prolonging the life of a socket without compromising the fit and function of the socket can be valuable to the patient and the prosthetist by reducing inconsistency managing volume fluctuations with sock ply and delays in responding to volume changes when a prosthetist is required to provide socket adjustments.

We propose adding an amputee adjustable non-elastic closure system to a custom socket designed with compressible panels. A customizable light weight, low profile closure/compression system with a non-slip mechanical reel, steel lace and nylon guides allows the patient to make infinite micro adjustments, by twisting a knob, to modify the socket fit without removing the socket. The custom design of the socket and panels provides global and/or localized compression of the socket around the residual limb. Thereby, transferring torque load from the user to the socket and the prosthesis for increased functional control. The closure system could be used for any level of amputation on immediate post-operative rigid, prepatory or definitive sockets.

Additionally this system can be utilized to aid in donning and doffing and create adjustable suspension designs all with a single handed operation that requires minimal force.

RESULTS

We have manufactured and successfully fit socket designs utilizing the adjustable mechanical closure system to accommodate volume fluctuations.

Custom Panels with Adjustable Closure for Volume Management

DISCUSSION

Further investigation is required to quantify the volume accommodation in a designed socket and to measure torque output with an adjustable socket.

CLINICAL APPLICATIONS

A custom amputee adjustable socket is of value to patient and prosthetist in order to provide immediate accurate socket fit and maximal functional control of the prosthesis. This closure system can also be used in orthotic applications where simple adjustable closure is indicated.

REFERENCES

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