Use of a Dynamic Load Strap in adjustable anatomical suspension for transradial amputations

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ABSTRACT

Background: Although dynamic load straps have been used in prosthetics and orthotics since the 1950s, to our knowledge, their use for suspension control in an upper extremity prosthesis has not been previously reported.

Purpose: We will present a case study that used a dynamic load strap as the posterior strut of a self suspending transradial prosthesis.

Method: This work was part of the VA study to optimize the DEKA arm. The subject was a 62 year old male. His right arm and leg had been amputated 43 years prior in a traumatic accident. He used the DEKA Arm with the dynamic load strap within the laboratory setting for 13 visits, over three weeks. The socket was a modification of the high fidelity design.

Results: The dynamic load strap served as an adjustable posterior strut, allowing the user to adjust the amount of suspension for comfort and activities. Use of the dynamic load strap eased the donning and doffing process, and allowed for preservation of pronation and supination movement.

Conclusions/Implications: The dynamic load strap was an effective option for use in suspension the transradial prosthesis. Dynamic load straps might also be useful within harnessing for sockets at other levels of amputation.

INTRODUCTION

The abandonment rate of upper extremity prostheses is high.¹ ⁶ Many studies cite the socket as a contributor to abandonment.⁴ ⁶ ⁷ There are several types of sockets used for transradial prostheses.⁸ The conventional socket uses flexible or rigid hinges and a triceps cuff for suspension. The use of flexible hinges allowed for pronation and supination. Self suspending designs including the Munster and Northwestern style sockets were developed. More recently, the anatomically contoured socket was developed⁷. This single case study we describe was part of a larger 4 site study of the DEKA Arm System. As of March 2011, a total of 26 subjects had been enrolled. The Generation 2 DEKA Arm is a modular arm which can be provided at the transradial, transhumeral, and shoulder disarticulation/scapulothoracic amputation (shoulder configuration) level. The subject we describe was a transradial amputee who used the radial configuration of the DEKA Arm. The socket style used in this study was the “high fidelity” style developed by Randall Alley subsequently modified for suspension with a Dynamic Load Strap.

Dynamic Load Strap is made up of a fiber braid with an interior pneumatic bladder. As the bladder inflates, the strap shortens. This provides an adjustable mechanism which does not require any buckles or snaps. One advantage of use of a flexible posterior suspension is the preservation of any native pronation and supination available.

METHODS

This work represents a single case of a transradial amputee who used a dynamic load strap as a posterior strut. The subject was a 62 year old white male Veteran. He had a traumatic distal third transradial amputation 43 years ago. He was a proficient user of a body powered system, although he rarely chose to wear it. He owned a myoelectric, but had rejected it. He had a sensitive pressure point near the distal end of the residuum near the distal radius. The initial check socket was rigid, and the dynamic load strap was added to the final socket.

Figure 1: Proximal and Posterior view Socket with Dynamic Load Strap. The posterior strut was comprised of the dynamic load strap. The attachment nozzle for the airbladder is shown in the lower right.
The subject was casted for a prosthesis. He was then seen for a diagnostic fitting with a rigid socket. In the final fitting, the rigid posterior strut was removed and a dynamic load strap was used in its place. The completed socket is shown in Figure 1. A comparison of the diagnostic and final socket is shown in figure two.

![Figure 2:](image1.jpg) Comparison of the rigid diagnostic socket and final socket with the dynamic load strap. The anterior and posterior openings were maintained, the posterior strut was replaced with the dynamic load strap, and the medial and lateral opening were removed to improve capture of native pronation and supination.

The subject used the DEKA Arm for 10 training visits lasting 2 hours each and 3 testing visits lasting approximately 3 hours each. We estimate that he had about 30 hours of wear time over the course of the study. The completed arm with DEKA hand is shown in figure 3.

![Figure 3:](image2.jpg) The completed arm with DEKA hand, and user display mounted on the forearm.

**RESULTS**

The dynamic load strap comprised the posterior strut, and provided suspension for the prosthesis. The dynamic load strap increased comfort, and was easier to don and doff than previous versions of the socket. In addition, the dynamic load strap allowed some native pronation/supination. During the second testing visit the subject indicated that he was “extremely satisfied” with the comfort of the prosthesis, although at other visits he expressed dissatisfaction due to the weight of the hand. Although we attempted to quantify amount of pro/supination, it was unclear how much was true motion and how much was compensatory. The subject was pleased with the socket, and inquired about using the socket for his body powered prosthesis.

**DISCUSSION**

The dynamic load strap is a promising method to provide a comfortable dynamic suspension which allows for residual pronation and supination. During this case, we used a manual pump to inflate and adjust the dynamic load strap. In the future it would be possible to use an automated control mechanism to inflate after donning, deflate for doffing, and adjust tension depending on loads or movement within the socket.

The subject was very pleased with the overall socket design, including the dynamic load strap. Since this was part of a study of the complete DEKA Arm system, much of the data collected did not isolate the contribution due to the socket design or dynamic load strap.

Future work will evaluate the extent to which a dynamic load strap improves range of motion at the transradial level. There may be other appropriate uses for dynamic load straps in transhumeral or scapulothoracic prostheses.

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**REFERENCES**


