

FITTING THE HUMERAL LEVEL BRACHIAL PLEXUS AMPUTEE WITH EXTERNALLY POWERED MYOELECTRIC CONTROL

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INTRODUCTION

Brachial plexus injuries present unique challenges to both the patient and prosthetist. The brachial plexus injury can be classified in many categories: complete or incomplete lesion, with either an intact or amputated limb as a result of the injury. The intact yet flail limb presents with lack of sensation, shoulder subluxation, severe pain, and is often subjected to unintentional burns and cuts. Many brachial plexus patients with an intact limb elect to undergo limb amputation to reduce complications or improve function with prosthetic fitting options. Unfortunately, some patients continue to experience similar post-amputation complications. Fusion of the shoulder joint is a surgical option in an attempt to decrease pain and reduce shoulder subluxation. This procedure may be performed before, after, or in association with amputation of the extremity.

BACKGROUND

Traditional prosthetic management for this type of patient includes both body powered and externally powered designs. Patients experience many limitations when fit with body powered designs due to inadequate range of motion in the shoulder region. Typical myoelectric fittings often failed due to the extreme difficulty in fitting this level. Patients find the weight intolerable and a poor socket fit leads to inconsistent readings at the myoelectric sites.

DISCUSSION

Myoelectric control offers many advantages for the high level amputee. Brachial plexus injury patients benefit from an aggressive prosthetic approach. In the last year, six patients have been fit as shoulder-level amputees using myoelectric control. Critical features of this approach include socket design and stabilization, as well as the location selection of myoelectric sites (i.e. trapezius, pectorals and rhomboids).

Inherent with this patient population, myoelectric site selection is often challenging. Site selection should be pursued with the knowledge that future adjustments or repositioning of the sites may be necessary and myoelectric training is required. One success factor is the design of a test socket with myoelectrodes installed and connected to an EMG analyzer. This allows the patient to receive ongoing and intensive therapy from an experienced occupational therapist prior to fabrication of the definitive prosthesis. Consistency of electrode placement with the donning and doffing of the prosthetic socket is also critical to successful myoelectric fittings. Once the patient has successfully isolated effective muscle groups, re-evaluation of site fittings is suggested and continued fitting toward a definitive prosthesis.

Rationale for fitting this patient group as a shoulder-level fitting as opposed to a humeral-level fitting includes: improved socket stabilization, myoelectric sites placed within prosthetic socket, increased range of motion with

prosthetic shoulder joint, reduction of force on the anatomical shoulder joint, easier donning/doffing of the prosthesis and clothes. As a result, improved functional independence can be achieved.

Obtaining an accurate cast begins by wrapping the residual limb and torso in Saran[®] wrap. Anatomical landmarks and initial trimlines are identified. The torso is wrapped with elastic plaster to create a base, over which rigid splints are then applied. Elastic ace wraps are applied over entire cast for compression before the plaster splints have set. Positioning of the residual limb and hand molding techniques establish the anterior-posterior dimension and proximal aspect of socket mold. After the mold is poured and rectified, 3/8" DurrPlex is pulled over the model to create the initial test socket for electrode placement and training.

The socket is a critical component of any prosthetic design. A modified shoulder-style frame socket is used to maximize stabilization of the prosthesis on the residual limb and torso. Loading of the anatomical shoulder girder is obtained through the pyramid-shaped socket, with anterior and posterior compression (Fig. 1). That feature, in combination with encompassing the trapezius area, eliminates any distal migration of the socket. Rotation is controlled through the posterior-proximal and anterior-distal aspect of the socket. The definitive prosthesis consists of a flexible inner-socket and a rigid laminated frame. The flexible inner socket improves patient comfort by allowing increased flexible, improved socket adjustability, and specialized design features such as "floating" electrodes. These combined features allow the patient to maintain electrode contact while retaining a greater range of motion.

There are various options in addressing the residual limb. These include enclosing the limb within the socket with or without a prosthetic shoulder joint or leaving the limb open and free. Harnessing considerations for this design must allow for ease of donning and provide adequate stabilization. Elastic harnesses attached to the flexible inner socket provide a dynamic assist to suspension and positioning of the socket.

Components

Shoulder joints commonly available for this design are friction flexion-abduction or locking flexion-extension with friction abduction. Alignment of the joint is slightly internally rotated and placed just distal to the anatomical shoulder joint. The joint is also placed as close to the residual limb as tolerated. It should also be noted that in most brachial plexus injuries, the shoulder is atrophied to a degree to allow for such placement of the joint while still allowing the prosthetist to provide a cosmetically acceptable definitive prosthesis.

There are a variety of prosthetic options and combinations of myoelectrically controlled externally powered elbows, wrists, terminal devices and controllers that will effectively address the needs of the patient. Specific component selection must be determined on an individual basis.

Diagnostic Phase

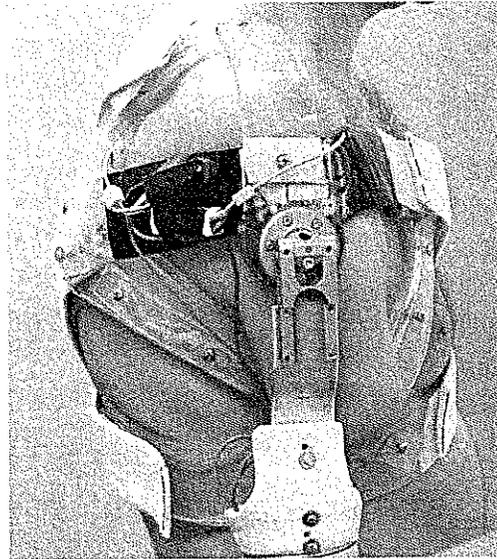
An initial rigid DurrPlex test socket is fitted and trimmed to simulate final socket design. A functional diagnostic test socket is then fabricated consisting of a flexible inner socket and rigid outer DurrPlex frame. (Fig. 2) At this point, shoulder joint placement is established and all components and electrodes are mounted. This diagnostic phase allows for continual adjustments to the socket, change of electrode site placement, movement or realignment of the shoulder joint, and determines the efficacy of the design and component selection to meet the needs of the patient. The patient is now ready for occupational therapy and prosthetic training. After undergoing intensive training procedures and all adjustments have been finalized, the prosthesis is ready to finish.

CONCLUSION

Six patients were fitted with similar designs outlined in this presentation. Four of the six patients had previously been unsuccessfully fitted with traditional designs. Two patients were new users. Functional skills and abilities were improved in all cases with 100% acceptance. Continued research and development will lead to functional improvements in components and design for unique patient groups such as brachial plexus injuries.



(Fig. 1) Forces applied from socket



(Fig. 2) Diagnostic prosthesis