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Integrating Electrodes in Silicone and a New Application for Myoelectric Suction Sockets

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ABSTRACT

There have been numerous attempts to integrate electrodes into liners to operate externally powered devices. Various methods and techniques have been tried from RTV laminated sockets to off-the-shelf liners as well as a number of thermoplastic techniques. All of these techniques, while providing improved suspension and comfort have limitations and drawbacks. However these limitations have not deterred prosthetists from pursuing these options in an effort to provide better control, better suspension and ultimately a better outcome. Through the experience of Otto Bock's Custom Silicone Services, we will present a number of solutions. These include challenging fittings such as the transmetacarpal as well as more standard levels.

Suction Sockets have been utilized in upper extremity fittings for many years now, but it has always been challenging to maintain suction in myoelectric fittings due to the difficulty of sealing around electrodes. A new solution developed by Otto Bock will also be presented.

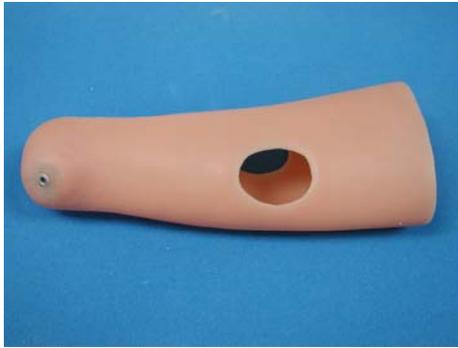
INTRODUCTION

As clinicians, we are constantly looking for ways to optimize prosthetic fittings. For externally powered devices, suction sockets have become a favourable suspension method. Many new techniques and materials are now available that are making suction sockets possible.

In this paper we will describe the progression of achieving full suction suspension using custom silicone liners. A silicone liner with electrode cut outs was first developed, followed by creating a liner with integrated electrodes. Recently, a new electrode developed by Otto Bock has made full suction suspension possible.

ELECTRODE CUT-OUTS IN LINERS

Silicone liners are fabricated with rectangular or circular openings at the electrode locations. This allows a more comfortable socket with partial suction suspension.



Applications:

- For fitting myoelectric prostheses to patients who are using silicone liners and still fabricate the devices in the standard way
- For longer residual limbs, the cut-outs are close to the proximal trimlines to maintain the suction fit
- For short residual limbs, the liner can be extended beyond the proximal brim of the rigid socket to maintain the suction fit

Liner Advantages:

- easily replaced if needed
- more thorough cleaning as liner is removable
- can be inverted for easier donning
- partial suction achieved

Disadvantages:

- tissue bulging out of the electrode cut-out areas could cause pinching when donning the device
- suction may be lost at the cut-out areas

Partial suction is achieved when silicone liners with cut-outs are used. The cut-outs could allow air to enter the liner and as a result suction may be lost. Along with this type of liner, a socket using standard fabrication techniques is required for mounting the electrodes. Since our goal was to achieve full suction with a liner for a myoelectric device, we developed another technique using integrated electrodes.

INTEGRATED ELECTRODES LINERS

Integrated electrode liners are fabricated to include a negative space in the silicone. The electrodes are mounted within the liner from the inside and the cable exits from a slit in silicone. These liners are always attached to the rest of the myoelectric device and can be used either as a "socket" on its own or with an outer socket.



Applications:

- For fittings where patients are able to insert their residual limb into the device without having to invert the liner
- For patients who can remove their residual limbs from the liner, without having to remove the liner from prosthesis
- For fitting myoelectric prostheses to patients who are able to use the liner as a "socket" without any lamination support

Advantages:

- Suction suspension can be achieved
- More comfortable for the patient since suction is achieved with full contact of the silicone on skin (no tissue bulging)
- Easier for patient – less parts, components which eases donning
- For increased stability, can be fabricated with lamination struts which in turn eliminate the need for a separate socket
- Channels can be made in the silicone for the electrode cables

Disadvantages:

- sometimes loose suction - when full contact is lost
- cleaning difficult as the liner cannot be removed – especially for the distal end of the socket in the case of a long residual limb
- bulky as a result of encapsulating the electrodes
- more time consuming

Although total suction is achieved, the silicone build-up around the electrodes creates a bulky prosthesis. Maintenance of the device is also a concern as the entire prosthesis must be disassembled. To correct these concerns, a new application for myoelectric suction sockets was designed using a different mounting system for electrodes.

SUCTION SOCKET ELECTRODES

Otto Bock has developed some new electrodes that snap into a rectangular cut-out in the socket. These electrodes are identical to the 200 electrodes but do not have any mounting extensions. They simply snap into the rectangular cut-outs of laminated, thermoplastic or even custom silicone sockets.



Applications:

(same as with integrated electrodes)

- Can also be used in custom silicone sockets or prostheses

Advantages:

(same as with integrated electrodes with additional benefits below)

- Can be used for traditional thermoplastic and laminated socket designs
- Improved suction as the electrode forms a seal around the cut-out
- The seal will prevent perspiration from damaging the electronics
- Easy to install
- Fabrication is simplified
- Low profile

Disadvantage:

- cleaning is difficult as the electrodes are connected by cables to the rest of the prosthesis, therefore, the liner cannot be removed

CONCLUSION

The suction socket electrodes have addressed the concerns of achieving total suction by the seal around the electrode cut-outs. The bulkiness of having to encapsulate the electrode in silicone has been eliminated.

One area still requiring research is in the development of a wireless electrode. This would be beneficial as it would allow the liner to be removed from the prosthesis with no cables attached. This would make the liner easier to clean and maintenance is facilitated as the entire prosthesis does not have to be disassembled.

As research and development continues in this area we can use existing techniques in different ways and adapt materials with new components to offer better fitting options to our patients.

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