Enhancing Your Comfort and Function Through Upper-Extremity Socket Technology

by Troy Farnsworth, CP, FAAOP

As technological advances improve the lives of individuals with upper-extremity limb loss, one thing remains constant: The most important part of any prosthesis is the socket, the part of the prosthetic device that attaches to the amputee's residual limb. Without a properly designed and fitted socket that is both comfortable and functional, your ability to benefit from your other prosthetic components will be limited.

Since far fewer individuals have upper-limb loss than lower-limb loss, however, it is more difficult for prosthetists to gain experience in dealing with upper-limb amputees. Unfortunately, this limits their ability to standardize solutions to prosthetic problems.

To add to the difficulty of ensuring a comfortable and functional socket, each wearer's individual needs and the prosthetic control system he or she chooses to use will determine the prosthesis' comfort, stability, range of motion, cosmesis possibilities, and method of attachment.

Body-Powered and Myoelectric Prostheses

The two main types of prosthetic control for upper-extremity prostheses are body-powered and myoelectric. In body-powered control systems, the need for control cables and a harness must be considered during the design and fitting process because the socket must be designed to efficiently capture and transmit body movements to operate the prosthesis. These systems tend to be easier to don (put on), and users may wear prosthetic socks or other liner materials between their residual limb and the socket for improved comfort.

In myoelectrically controlled systems, on the other hand, surface contact with electrodes against the wearer's skin is essential. To ensure proper function of this type of system, therefore, the socket must stabilize the electrodes against the muscle belly, while still allowing the muscle to comfortably contract within the socket. In most myoelectric sockets, the wearer's skin comes in direct contact with the socket to provide optimal functioning of the system.

Suspension Methods

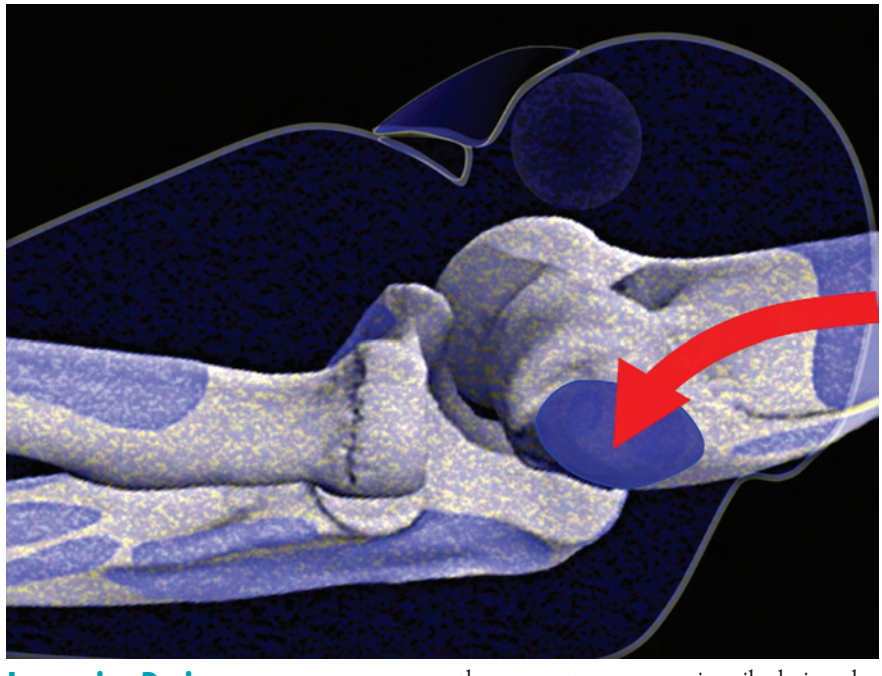
The method of keeping the socket attached to the residual limb (the method of suspension) is also extremely important. Upper-extremity prostheses must be suspended throughout the entire range of motion as well as be able to tolerate loading during normal use.

Suspension may be gained through

- Harness systems, in which straps hold the prosthesis to the body
- Contouring of the socket around the wearer's remaining bony anatomy (self-suspending)
- Suction
- Silicone liners with locking mechanisms
- External suspension sleeves.

Various modifications and combinations of these methods can address the specific requirements of each prosthesis wearer, depending on his or her needs.

Silicone locking liners have become increasingly popular for use in body-powered and passive systems as well as a limited number of myoelectric systems. These locking liners provide excellent suspension and can reduce some of the discomfort associated with traditional harness systems.



Improving Designs

Innovative upper-extremity sockets have been developed over the last decade for all levels of limb loss. These designs are slowly becoming clinical standards and are being taught at schools around the country. As the new designs were being developed, the best features from older designs were incorporated with new concepts derived from in-depth studies of upper-extremity anatomy throughout the range of motion. Although many of the new systems were primarily designed for myoelectric applications, most can be modified for other control types. The Anatomically Contoured and Controlled Interface (ACCI) socket was designed for transradial (below-elbow) users, while the Advanced Humeral Interface (AHI) socket was developed for transhumeral (above-elbow) users. Finally, for thoracic-level (shoulder disarticulation, forequarter, and some "humeral neck") fittings, the X-Frame Interface was developed.

These modern socket interface systems rely on advances in material technology. Flexible inner socket materials have enabled sockets to more accurately contour the limb and yet remain more comfortable than older designs. For example, in traditional below-elbow myoelectric sockets, the prosthetist will typically lower the anterior (front) brim of the socket to allow the remaining elbow greater range of motion. In contrast, the flexible material in an ACCI socket promotes raising the anterior brim to better control soft tissue and increase functional range of motion. This drastic change also increases the lifting surface area within the socket, enabling the wearer to easily handle heavier objects with greater comfort and stability.

Flexible inner sockets also allow greater adjustability once the prosthesis is fabricated. Changes to the fit of the socket can be made, within reason, directly to the inner flexible liner without requiring refabrication of the entire prosthesis. This will help extend the functional life of the system, but it may or may not accommodate major changes that occur within the wearer's residual limb. It is, therefore, important for all prosthesis users to maintain a healthful lifestyle that will stabilize their body weight and composition.

New materials have also simplified the process of donning "pull-in" sockets. These sockets depend on the user correctly "pulling" the tissue of his or her limb into the contours built into the socket for proper fit and function. Nylon donning sleeves make this much easier than the traditional methods. Although

"push-in" designs are used by some individuals, these sockets may not allow sufficient contouring and control of the tissue to optimize the fit and function of the prosthetic system. For long-term successful use of the prosthesis, it is extremely important for the wearer to consistently don the prosthesis as he or she was initially instructed. If you are unable to consistently don your prosthesis in the manner you are taught, or if there are any other concerns, you should consult with your prosthetist to ensure that your system will still perform optimally.

Caring for Your Socket

It is important to care for and maintain your socket. This includes cleaning and inspecting it daily. Usually, mild (antibacterial) soap and water is recommended for cleaning. You should consult with your prosthetist about the specific requirements for your system.

The Optimal Socket

Once an optimal socket is designed and fitted for you, you should be able to experience the benefits of modern prosthetic components. A proper well-fitted socket combined with the appropriate components should give you the greatest chance of success with your prosthetic system. ■

About the Author

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