

# Advances in Upper-Extremity Socket Designs

by Wayne Daly, CPO, LPO, FAAOP

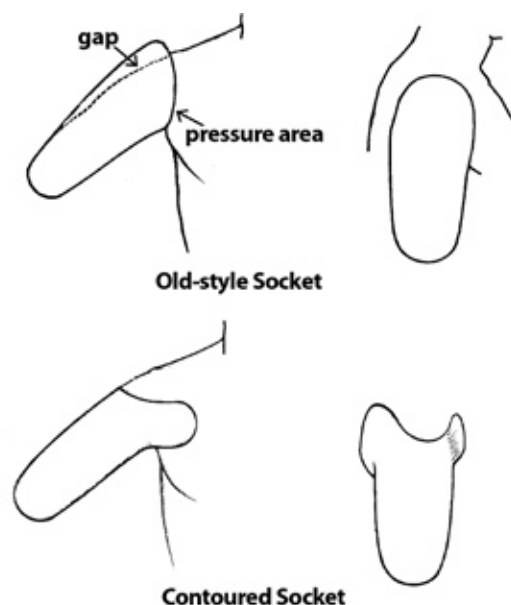
Newer sockets are shaped to capture the anatomical features of the limb, which can provide better suspension and control of the prosthesis and, in turn, increase the function of the limb. Examples of changes in socket shape are the anatomic contoured transradial socket, the narrow ML (medial-lateral) transhumeral design, and the X-frame socket used in shoulder amputations.

Work by many practitioners has concentrated on using the anatomic contours of the forearm and torso to increase the suspension and range of motion (ROM) of the prosthesis. One such transradial socket design is the Anatomically Contoured and Controlled Interface (ACCI), which uses flexible socket walls and fits the anatomic contour of the forearm to suspend the prosthesis (Illustration 1). By capturing the shape of the elbow, it is often possible to improve the stability and ROM of a transradial prosthesis for a short residual limb.



*Illustration 1*  
Example of Anatomically Contoured and Controlled Interface socket.  
Photo courtesy of Randall Alley, CP, FAAOP

Other designs to improve prosthetic function have evolved for other lengths and levels of amputations. One such design is the narrow ML transhumeral socket, which incorporates a modified shape that takes advantage of the shape of the residual limb to provide better rotational control and increased function. One such design modification, called the Utah Dynamic Socket, accentuates the shape of the upper arm to provide rotation control and improved suspension (Illustration 2). This socket, which may be used with either a sock fit or a skin fit, locks onto the contours of the upper arm, providing a stable, highly functional prosthesis.



*Illustration 2*  
Comparison of narrow ML socket to conventional socket shape. Based on information from J. Thomas Andrew, CP, FAAOP. Used by permission.



*Illustration 3 Range of motion possible with a roll-on suspension prosthesis.*

One major change in suspension technique has been the application of roll-on liner suspensions for upper-limb prostheses, which provide not only improved suspension, but also better comfort and greater range of motion for the prosthesis. Conventional transradial self-suspending sockets rely on pressure above the elbow to hold the prosthesis in place and this can lead to discomfort and reduced ROM. With the roll-on suspension design, the liner provides the suspension, while the gel protects the skin from pressure and friction. The looser fit of the roll-on designs can provide increased ROM since the soft suspension allows the arm to move in the socket and relieves many of the pressure points associated with a conventional self-suspending socket design. Many liners also incorporate mineral oil or aloe vera extract to protect the skin from abrasion and to help with scar tissue healing. Another important consideration is that conventional skin fit suction socket designs use one-way air valves or external sleeves for suspension and require a stable limb volume to maintain suction. Roll-on suction liner designs provide a more flexible suspension that will accommodate greater

volume changes in the limb. This ability to accommodate significant volume changes allows a prosthesis to be fitted earlier in the healing process than a conventional design without loss of comfort or suspension.

This roll-on liner design can be used for suspension with conventional or myoelectric arms. In the myoelectric design, the electrodes are attached through the liner to



*Illustration 4 Shielded cables and electrodes.*

provide more stable electrical control, better suspension, and greater ROM (Illustration 3). This design uses stainless steel electrodes and shielded cables to send the myoelectric signal from the remote electrodes, which improves suspension and electrical contact (Illustration 4).

For higher-level amputations, other designs have evolved to improve the fit and function of the prosthesis. Shoulder-level amputations have often been difficult to suspend and are often uncomfortable due to the large area of skin covered by plastic. The poor stability of a shoulder disarticulation socket has also limited the function of the prosthesis. One design that seeks to reduce these problems and increase the wearing comfort is the X-frame shoulder socket. The X-frame socket uses very rigid materials to maintain a shape that will lock into the wedge-shaped anatomy of the upper torso, providing a secure anchor for the prosthesis, which, in turn, increases its stability and function. This shape allows the socket to be much smaller and thinner, as well as cooler and lighter, while maintaining secure suspension. With the use of newer carbon composite lamination techniques, the production of thin, lightweight, but very rigid, frames is possible for shoulder prostheses. All of these changes provide better function and usefulness for the prosthesis. ■

### **About the Author**

*Wayne Daly, CPO, LPO, FAAOP, has 28 years experience in the prosthetics and orthotics field. He is American Board certified and was recently named a Fellow of the Academy. He holds a Bachelor of Science in Prosthetics & Orthotics from the University of Washington where he was a lecturer for seven years.*

