MANAGEMENT OF THE VERY SHORT/HUMERAL NECK TRANSHUMERAL AMPUTEE

Jack E. Uellendahl, CPO Hanger Upper Extremity Prosthetics Program

Prosthesis control for persons with very short (axilla level) transhumeral (VSTH) amputation can be challenging. Due to the short lever arm, fully body-powered options are often not possible due to the lack of available excursion. In some cases it is possible to use ballistic control of an elbow with Automatic Forearm Balance yet terminal device control is still problematic. When an electric hand is desired, myoelectric control is preferred. However, consistent contact of the electrode(s) using a current state-of-the-art TH socket design may not be possible.

Roll-on Silicone Suction Sockets (3S) using snap electrodes have been employed for the VSTH interface with limited success. Due to the absence of a limb projection, the 3S socket often cannot maintain suspension and electrode contact is lost. When the liner is mechanically connected to the prosthesis though a locking liner, motion of the prosthesis tends to work the liner off of the limb. Even when a non-locking cushion liner is used, sweat and residual limb motion can cause the liner to lose position on the limb and thereby compromise electrode position.

Another alternative is to use a linear transducer using scapular motion for control with a TH socket. Because this type of control is body position sensitive, it can be difficult to separate the control motion from other body motions such as reaching forward, which causes inadvertent hand function.

Shoulder disarticulation socket designs provide an alternative but also present problems. A thoracic frame type interface can be designed to provide good electrode contact. However, treating the VSTH as a shoulder disarticulation complicates the prosthesis due to the need for a prosthetic shoulder joint. Location of the shoulder joint is problematic because the physiological shoulder joint is present and there is no space for a prosthetic joint to be positioned in a natural and cosmetic location. Also patients fitted in this way often feel overly encumbered by the more extensive socket and tend to prefer a less inclusive socket if appropriate function and normal appearance can be attained.

It is the author’s opinion that this patient group stands to benefit greatly from emerging technology and surgical interventions using implantable electrodes with or without neuromuscular reorganization as proposed by Kuiken. If myoelectric signal acquisition can be accomplished with implanted electrodes and control signals are wirelessly sent to the microprocessor controller, requirements for prosthetic socket fixation may be reduced. Neuromuscular reorganization would allow for more natural hand control using signals originating at the physiologically appropriate nerves. Normally innervated biceps and triceps can then be used for myoelectric elbow control or the elbow can be cable controlled.
Figure 1 shows a VSTH amputee (DD) fitted with a thoracic frame socket using 2 site myoelectric control of his terminal device and a passively positioned elbow.

Figure 2 shows a VSTH amputee (RR) without his prosthesis.

Figure 3 shows RR fitted with his prosthesis using linear transducer for control of his Sensor hand and ballistic control of his AFB elbow. Chest expansion operates the elbow lock using this thoracic harness system.

Figure 4 shows a VSTH amputee (JS) without her prosthesis.

Figure 5 shows JS with her prosthesis. In order to provide a more cosmetic result a figure 8 harness is used for suspension avoiding visible straps when wearing open neck blouses.

Figure 6 shows JS from the back. A linear transducer provides control of the Sensor Speed hand. The elbow is passively positioned.
References:


