

Upper Extremity Prostheses

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Each prosthesis consists of a method of suspension that holds the prosthesis to the body; a socket into which the stump fits; mechanical joints (in above-elbow amputations) designed to approximate lost joint function; a terminal device utilized for grasping and designed to approximate, at least in part, hand function; and a source of power to operate the terminal device (either muscle control or external power sources).

Upper extremity prosthetic joints are relatively simplistic in their action and usually move in only one plane. Generally a passive joint is used, although in myoelectric or biomechanical devices, externally powered joints may, on occasion, be considered. Joint stabilization is usually accomplished with mechanical locks or various types of friction devices.

One of the most important parts of the upper extremity prosthesis is the terminal devices designed for pinching, holding and grasping, often referred to as a hook or artificial hand. A broad range of such devices are manufactured. Special terminal devices that perform very specific functions are also available and may involve a broad range of costs.

Although sensation cannot be transmitted by the terminal device or prosthesis, many individuals who become particularly adept at using the prosthesis can get a sense of what is occurring at least in terms of applied pressure at the point of the terminal device. This comes from the strap and harness assembly and a sense of the amount of pressure being applied by the individual in working the prosthesis. Most feedback comes from other sense, particularly sight.

The most common suspension device in upper extremity amputations is the figure of eight harness, which secures the prosthesis to the opposite shoulder utilizing straps that cross over the back. The socket itself, is custom-fitted to the stump, requires periodic checking, maintenance, and re-fitting, particularly if the stump atrophies, or, for any reason changes in size. Failure to maintain a proper stump and socket fit could result in skin breakdown and potential skin ulceration. The stump should be maintained in total contact with the socket and the stump sock should always be worn.

The patient should be instructed in stump care, including twice daily washing and drying of the stump and the proper wearing and cleaning of the stump sock. The stump sock is designed to absorb perspiration, cut down on skin irritation, and prevent direct contact between the sensitive stump skin and the prosthetic socket. Instructions from the prosthetist on cleaning the prosthesis (particularly the washable parts of the harness) should also be given. Prosthetic maintenance is an essential part of overall amputee care.

In instances where mid-carpal amputations or finger amputations are involved standard prosthetic designs do not exist and prosthesis must be custom-fabricated by prescription. This is usually more for cosmetic purposes and essentially does not provide any additional function. It is not uncommon to find individuals requesting more cosmetic prosthetic devices immediately after surgery but discarding them when it becomes clear that they add no significant function. This is seen most often in mid-carpal amputations, multiple finger amputations, shoulder disarticulations, and forequarter amputations. However, this is not to suggest that such devices should not be bought because they may well serve a useful purpose to the client at least from a psychological standpoint, at the time that they are fitted and used.

In the first one to two years after surgical intervention for an upper extremity amputation physician follow-up every three to six months is common. Prosthetic follow-ups should be accomplished every six months to one year during the first two years and at least once a year thereafter for prosthetic maintenance and adjustment. A change in prosthetic sockets may be required two times in first two years because of changes in the stump size relative to muscle atrophy. Good stump and prosthetic care will alleviate many of the complications, which can plague the amputee.

Prosthesis- Forequarter or Interscapular- Thoracic Amputation

Available prosthetic fittings for a forequarter amputation are expensive and limited in function. A forequarter prosthetic device (cable-controlled) costs \$3500-\$4500 and adds little additional capacity for grasping, lifting, or amputation. Generally, prosthetic devices in general must be replaced every three to five years and it can be assumed that this will most likely be the case for forequarter cable-controlled prosthesis as well. This device will most likely suffer less general wear and tear because limitation in function may result in less frequent use by the amputee.

Additional independence in function can be fostered by the purchase of appropriate aids listed in Table 4. These aids generally are inexpensive and, on the average, require replacement every one to two years as a result of wear, breakage, and loss.

Prosthesis- Shoulder Disarticulation/ Short Above-Elbow Amputation

Prosthetic fitting for a shoulder disarticulation and short elbow amputation is essentially the same. The prosthetic device (cable-controlled) costs approximately \$2500-\$3500, while terminal devices (for grasping) run \$350 to \$1000, depending on the device necessary. Only limited function can be obtained with these prosthetic devices. They serve primarily for cosmetic purposes or for opposition in bimanual activities.

Prosthesis- Above-Elbow Amputation/Elbow Disarticulation

The average cost of a standard above-elbow prosthesis (cable- controlled) is

generally \$2000 to \$2500, with terminal devices adding from \$350 to \$1000 to the total. In the elbow disarticulation, prosthesis costs generally average \$2000 to \$2500 with terminal devices again costing between \$350 and \$1000. The prosthesis with which the above-elbow amputee is fitted generally includes an elbow-locking mechanism and an elbow turntable. The elbow lock allows for strap on of the joint at any point from full extension through full flexion and allows the prosthesis to be used to assist the non-injured extremity in lifting and carrying activities. The turntable mechanism allows for external rotation.

Prosthesis- Short, Medium, and Long Below-Elbow Amputations

Below-elbow prostheses cost \$1400 to \$2000, on the average with terminal devices ranging from \$350 to \$1000. A more unique prosthetic device known as Muenster below-elbow prosthesis involves an above-biceps insertion and costs approximately \$1400 to \$2000. Its terminal devices range in price from \$350 to \$1000 when equipped with solid hinges, may raise the cost to \$525 to \$1175.

Prosthesis- Wrist Disarticulation

Training by the occupational therapist and physical therapist overlaps periods of total and partial disability. By the end of two months prosthetic fitting should have been accomplished. The wrist disarticulation prosthesis is a relatively simple device that costs approximately \$1400 to \$2000 and generally requires less in the way of maintenance than other upper extremity prostheses.

Prosthesis- Partial Hand Amputations

The cost of a wrist disarticulation prosthesis is \$1400 to \$2000. There are also two special surgical techniques, cineplastic amputation and Krukenberg surgery, which have been used to increase function.

The cineplastic amputation is a surgical procedure, which forms the stump so that the patient can directly activate the prosthesis by a motor within the muscles of the stump rather than by movement of the extremity or by remote control from the opposite shoulder. This twofold procedure, which actually changes the anatomical shape or structure of the stump, is described by Robert Tooms (Campbell's Operative Orthopedics, 1980, page 867):

"The motor is composed of (1) an inverted tube skin flap, the inside of which is lined by normal skin that has been drawn transversely through a muscle tunnel at right angles to the line of muscle pull and fixed to the opposite side, and (2) a peg that is placed within the tube to transmit muscle power to the prosthesis by means of control cables attached to its ends." This is a relatively rare procedure at this point in time and is not often encountered by the rehabilitation counselor.

In the Krukenberg procedure a "lobster-claw" is constructed below the elbow. The stump is actually anatomically changed to create a crude pinching mechanism. It is a rarely performed, particularly in the United States, due in large part to the grotesque appearance of the amputated stump subsequent to

surgery.