Fitting Technique for Very Short Below-Elbow and for Partial Hand Amputations

By WILLIAM A. TOSBERG, C.P.O.

Technical Director, Prosthetic Services
Institute of Physical Medicine and Rehabilitation
New York University Medical Center, New York City

A very basic definition of a prosthesis would be: a mechanical device to replace lost function and cosmesis. Based on this definition, it is apparent that a prosthesis which replaces the loss of an upper extremity would satisfy this definition to a different degree than a prosthesis for the loss of a lower extremity.

The functions of the lower extremities are primarily support and ambulation, whereas the function of the hand alone is so complicated that a complete functional substitute would be almost unthinkable. Most upper extremity terminal devices aim to duplicate only the most essential functional loss of the hand, namely, prehension. Many hooks and artificial hands have been designed for this purpose. The degree of function and cosmetic replacement varies considerably from device to device, but that is not the subject of this discussion.

In order to obtain the ultimate value of a prehensive device it is necessary to place it in contact with the object to be grasped and also to move the object within different planes of motion. This requires a prosthesis to which the terminal device is attached and also an operating system to activate the terminal device. The design of such prosthesis is governed by the level of amputation. The functional loss of the upper extremities is directly related to the level of amputation. Prostheses are therefore designed for these different levels of amputation such as wrist disarticulation, long below-elbow, medium below-elbow, short below-elbow, very short below-elbow, and for the different levels either through or above the elbow.

It is standard procedure to fit a short or very short below-elbow stump with either a split socket with step-up elbow hinges to obtain sufficient forearm flexion and extension or to utilize a short stump to activate an outside elbow lock. A biceps cuff would be used for suspension of the prosthesis and also for placement of a reaction point for the activating cable and harness system.

In the case of a split socket the relationship of motion between the stump and forearm varies with the relation of one to two—for every ten degrees of motion of the stump the prosthetic forearm moves twenty degrees. The increased range of motion of the forearm is obtained at the expense of effective torque available around the elbow. This in many cases forces the prosthetist to utilize a harness-controlled elbow-lift assist.

Where a very short stump has been utilized to lock an outside elbow joint by means of a split socket, the forearm stump is no longer able to effect elbow flexion or extension. By necessity, either one of these constructions is bulky and subject to increased mechanical failure and additional maintenance.

A harness is used to activate the power and control transmission, and also for suspension of the prosthesis. Where high loads are to be applied is becomes necessary to transmit high forces to the opposite shoulder. In many cases this has led to complaints of discomfort and, in some isolated cases, to pressure on the brachioplexus nerve with all its related dangers.

During several visits to Europe, the writer became familiar with a fitting procedure which was first seen at the University of Muenster, where it was developed by Professor Oscar Hepp and Dr. Goetz-Gerd Kuhn. Even extremely short stumps were utilized for the activation of the forearm shell of the prosthesis.

Fig. I—Very short below-elbow in full flexion

Fig. II—Palpation of biceps tendon

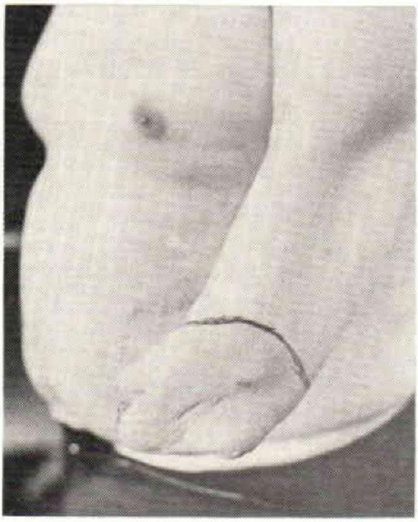


Fig. III—Proximal border of below-elbow socket

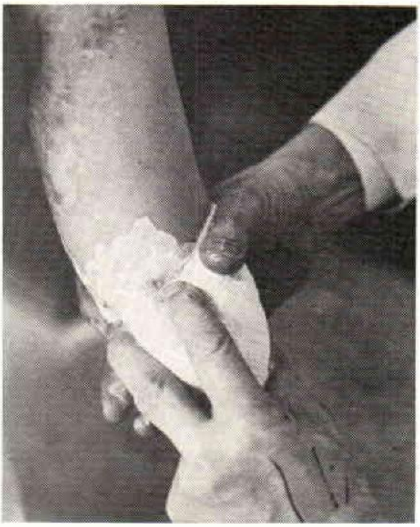


Fig. IV—Plaster-of-Paris cast being modified

The major fitting problems of the very short stump stem from the fact that the biceps tendon bow-strings across the elbow fold. This makes the short stump seem to disappear. (Fig. I). On careful palpation, however, it is possible to isolate the biceps tendon (Fig. II) and, if in the forearm socket sufficient space is provided for this bow-string tendon, the socket can be carried up into the elbow crease in order to provide sufficient surface for the stump to activate the forearm shell.

In order to prevent the stump from sliding out of the socket, the posterior as well as the medial walls of the socket are carried sufficiently high to include the condyles of the humerus, as well as the olecranon. In order to obtain such a socket, a cast has to be taken with extreme care. It is our practice to mark the stump with an indelible pencil in order to transfer the marks to the negative cast. The humeral epicondyles and also the prominence of the olecranon are carefully marked, as well as the proximal border of the intended socket. (Fig. III). The cast is best taken with elastic plaster-of-Paris bandages, with the stump held in approximately 30 to 40 degrees of elbow flexion, depending upon the length of the stump. The shorter the stump the greater the flexion. As soon as the cast is applied, the patient is asked to go through the full range of motion. This is possible since the plaster-of-Paris bandage will conform to the changed stump contours of flexion and extension. Before the plaster sets, however, the index and the middle finger are placed medial and lateral to the biceps tendon. The other hand encircles the top of the cast in the manner indicated in figure IV. The positive cast is not modified, with the exception of the prominent bones, where as much as one-quarter inch may be added to the olecranon and one-eighth inch to the epicondyles.

In the case of a tapered stump it is best to construct a double wall socket. Otherwise, the construction of the prosthesis proceeds in the usual manner.

Figure V shows the prosthesis with the elbow in extension. Figure VI shows the prosthesis in flexion. Figure VII shows a prosthesis of this type

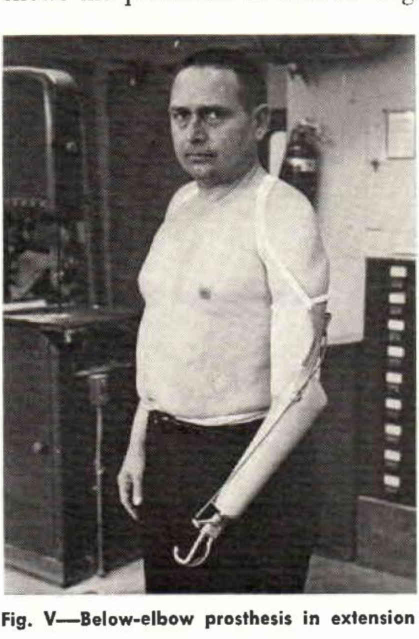


Fig. V—Below-elbow prosthesis in extension

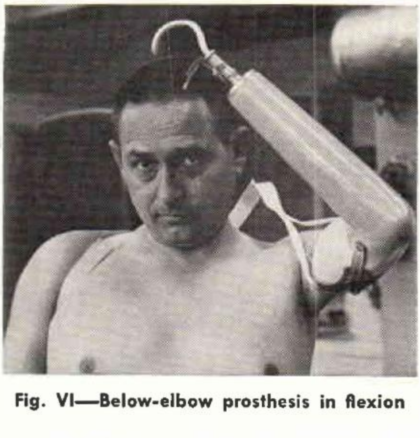


Fig. VI—Below-elbow prosthesis in flexion

Fig. VII—Impingement of posterior proximal border on triceps tendon

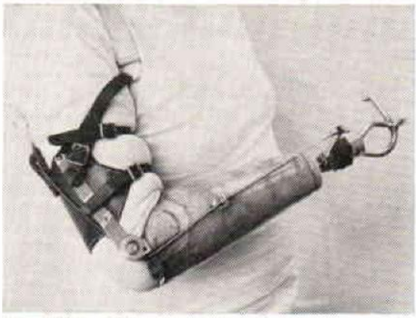


Fig. VIII—Old prosthesis of same amputee as Fig. VII

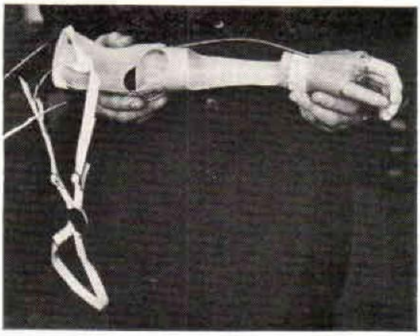


Fig. IX—Wrist disarticulation prosthesis

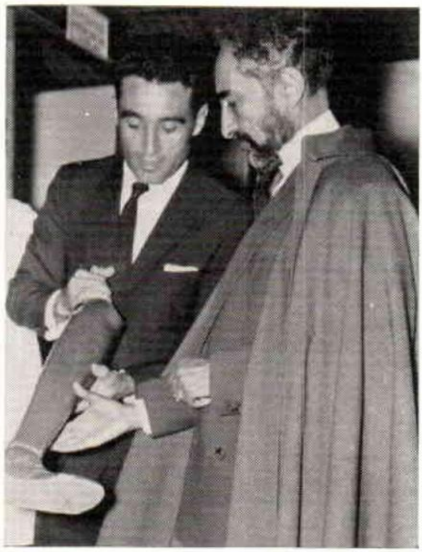
Fig. X—Wrist disarticulation prosthesis in pronaton

Fig. XI—Wrist disarticulation prosthesis in supination which has been worn for almost three years. The picture illustrates the impingement of the posterior proximal border on the triceps tendon. This man routinely lifts 30 to 50 pound weights with his artificial arm, with no tension on his harness. Figure VIII shows the prosthesis previously worn by him.

The fitting technique as used at the Institute of Physical Medicine and Rehabilitation for partial hand amputation, as well as for wrist disarticulation and very long below-elbow stumps, is shown in figure IX. The socket is carefully fitted to the distal contours of the stump. The fit at the elbow is similar to the procedure previously described but plastic laminate between the proximal and the distal fit is removed, as shown in this picture. The width of the remaining strip connecting the proximal and the distal part of the socket varies with the ability of the patient to pronate and supinate. Figures X and XI indicate range of rotation of this particular amputee, with the elbow in full flexion. Since pronation and supination are the result of the rotation of the radius around the ulna, relatively little motion takes place on the ulna side and, therefore, a fitting of this type causes hardly any limitation of rotation in the average amputee.

Juan Monros Receives Award in Ethiopia

Mr. Juan Monros, World Rehabilitation Fund instructor in the making of artificial limbs and braces, has been awarded the Haile Selassie I Gold Medal by the Kingdom of Ethiopia in recognition for his services as United Nations' consultant in prosthetics to the Appliance Workshop of the Princess Tsehai Memorial Hospital. His Imperial Highness Haile Selassie I participated personally in the dedication of the new Appliance Workshop which is operated by the Fund for the Disabled.



MR. MONROS AND EMPEROR HAILE SELASSIE

Mr. Monros is a Spaniard who had four years of training in prosthetics and orthotics at the Institute of Physical Medicine and Rehabilitation, New York University; Institute for the Crippled and Disabled; and at the Veterans Administration, New York City on a fellowship from the World Rehabilitation Fund.

Since completing his training in June 1961 he has been conducting short courses for the training of bracemakers and prosthetists in Peru, Haiti, Brazil (two courses) and India as well as Ethiopa. He has also visited prosthetics services in 28 different nations.

In June, Mr. Monros leaves on a three-and-one-half month assignment to India, Pakistan and Egypt on behalf of the Vocational Rehabilitation Administration, United States Department of Health, Education, and Welfare and the World Rehabilitation Fund, Inc.