Harnessing Methods for Children with Above Elbow Amputations

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The tendency of the above elbow prosthesis harness to shift and rotate during use is a major deterrent to comfort and optimum function. This instability of the harness can become a primary cause of prosthesis rejection, particularly among young children.

The apparent need for a more stable harness for above elbow prostheses led the author, as part of his work with the Engineering Artificial Limbs Project of the Department of Engineering at the University of California at Los Angeles, to design a new harness, incorporating what were considered to be the best features of several above elbow harnessing devices already in existence. This new design, a chest strap harness, is being used by numerous prosthetists throughout the country, and has also been adopted for use by the Child Amputee Prosthetics Project at the University of California at Los Angeles.

In adapting this harness design to meet the substantially different needs of children, certain major considerations became apparent: not only must the device be smaller without sacrifice of efficiency, but the more diffuse, more gross physical activities of the child, as contrasted to the better directed and infinitely more precise movements of adults, must be considered. In addition, the small body surface areas and delicate contours of the child pose difficult design problems. The shoulder of a young child, for example, does not provide an area large enough or sufficiently well-developed to hold a conventional harness strap.

This new harness, which has proved to be highly satisfactory even with very young children, consists of the following components:

1) A *chest strap,* which is anchored near the posterior lateral proximal rim of the socket, passes over the shoulder and across the chest, under the axilla and across the back, re-crossing the shoulder to fasten on the anterior lateral proximal rim of the socket.

2) A *back strap,* which is fastened to the chest strap posteriorly near the axilla and anchored to the control attachment strap at the inferior angle of the scapula.

3) An *over-shoulder strap,* which runs from the back strap over the shoulder to the deltopectoral triangle area, where it is folded, laid across the chest to the midline, and anchored to the chest strap. (This over-shoulder strap is also folded posteriorly to form the back strap.)

4) An elastic *front suspension strap,* which is anchored at the anterior fold of the over-shoulder strap and attached to the medial anterior portion of the prosthesis, above the turntable.

5) An *elbow-lock billet*, anchored at the anterior fold of the over-shoulder strap and attached to the elbow-lock cable.

6) A *control attachment strap*, secured at the posterior fold of the over-shoulder strap and attached to the terminal device cable hanger.

Method of Fabrication

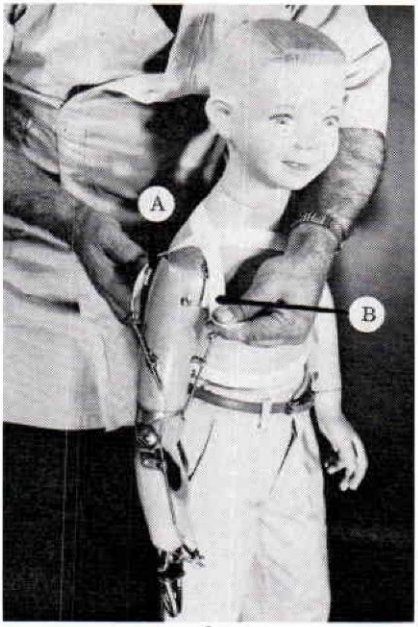
Step 1: One-inch webbing is placed from point A (Figure 1) near the lateral posterior proximal brim of the socket, over the shoulder and across the chest, under the axilla and re-crossing the shoulder on the amputated side to fasten at point B (Figure 1) near the anterior lateral proximal brim of the socket. Sufficient webbing should be allowed for a loop at each end to strengthen the snap fasteners. (Clamps may be used throughout the entire measuring and fitting procedure.)

Step 2: The over-shoulder strap (which must be long enough to be folded posteriorly to form the back strap, and anteriorly to join the chest strap at the midline) is placed as illustrated in Figure 2. (For the average 6-year old child, allow about 10 inches of webbing for the back strap portion and 8 inches for the anterior fold.)

Step 3: Clamp the over-shoulder strap at point C (Figure 2). Fold the anterior portion of the over-shoulder strap as shown in Figure 3, at about the deltopectoral triangle area. Secure the end of the folded portion to the chest strap at approximately the midline of the amputee.

Step 4: At this anterior fold, secure a piece of elastic webbing about 8 inches long (Figure 4). Exert a slight pull on the elastic webbing and fasten it to the anterior medial portion of the prosthesis just above the elbow turntable. This elastic webbing, under slight tension, insures the return of the elbow-lock alternator.

Step 5: A piece of half-inch webbing, fitted with an adjuster, is used for the elbow-lock billet. The webbing is attached to the elbow-lock cable hanger and secured at the anterior fold of the over-shoulder strap next to the elastic webbing used in Step 4 (See Figure 5).



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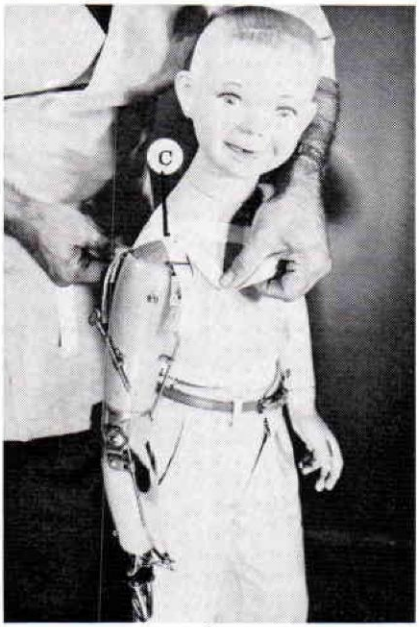

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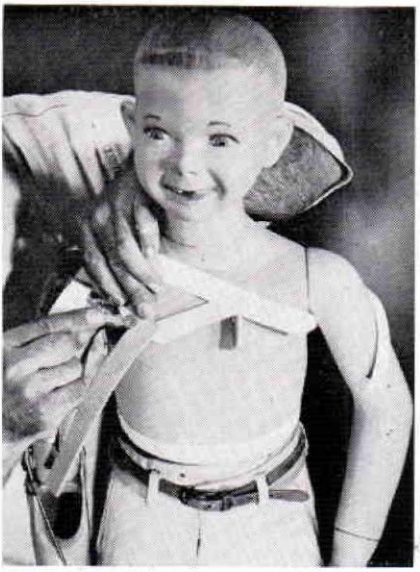

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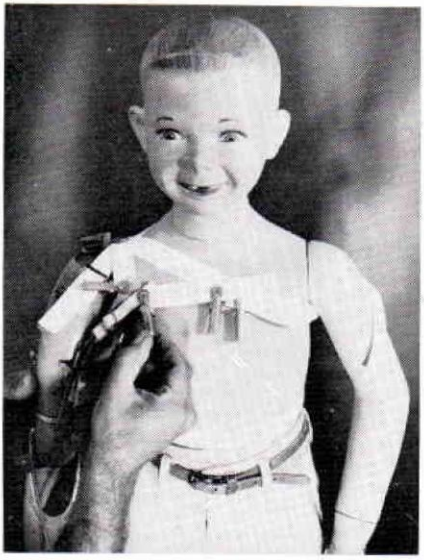

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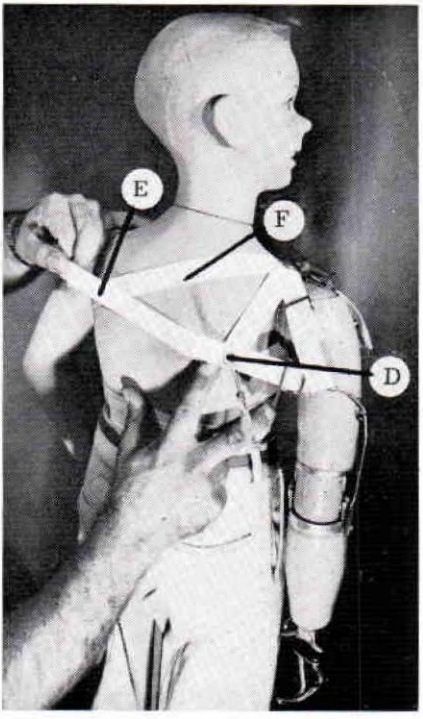

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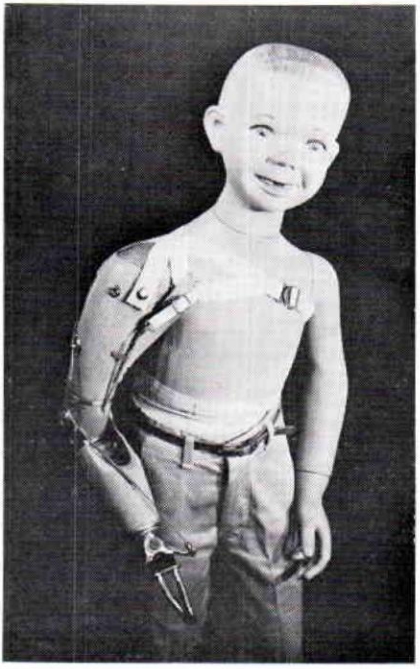
Step 6: Posteriorly, fold the over-shoulder strap at the point just above the inferior angle of the scapula (Figure 6) and secure it to the posterior aspect of the chest strap, near the axilla.

Step 7: The control attachment strap, fitted with an adjuster, is attached to the terminal device cable hanger, and secured to the posterior fold of the over-shoulder strap at point D (Figure 6).

Step 8: The back strap (from point D to point E, Figure 6) limits the freedom of arm movements, but gives greater excursion and power for a short stump. The back strap can be positioned along the posterior aspect of the chest strap between points E and F (Figure 6). The closer it is moved to F, the more freedom it allows—but with lessened excursion and power. The same increase in freedom (again with lessened excursion) can be achieved by raising the fold (point D, Figure 6). To determine the best placement of the back strap and the fold of the over-shoulder strap, all straps should be clamped in place and the amputee directed to operate the control. Observation of prosthesis function will indicate proper placement of the back strap.

Step 9: Remove the harness and box stitch at all points which have been clamped. The point of intersection of the chest and over-shoulder straps (point C in Figure 2) is both box and cross-stitched.

Step 10: An adjustable buckle is inserted anteriorly near the mid-point of the chest strap (Figure 7) for easy removal of the prosthesis.



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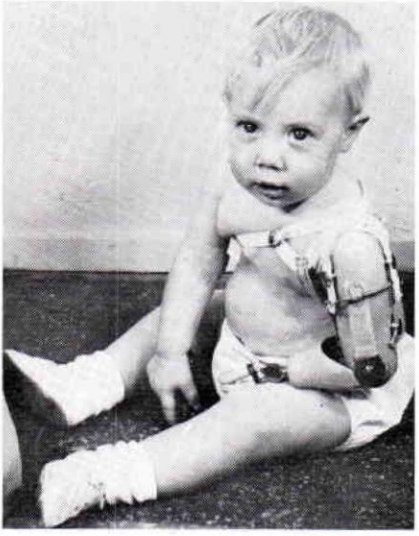


A Child fitted at 10½ months with an elbow disarticulation prosthesis, 12-P Dorrance hook and passive operation.

Harnessing For The Very Young Child

Dr. Craig Taylor and Dr. Hilde Groth of the Biomechanics group in the Department of Engineering at the University of California at Los Angeles have made a study of harness strap size for children, and on the basis of their findings have recommended that the half-point of the surface area growth in the child's development be the criterion for the change in strap width. Therefore, at approximately the time when the child reaches a weight of 50 pounds, the harness webbing is changed from ½-inch to 1-inch width (except on the elbow-lock control, for which ½-inch webbing is used). Although ¾-inch or ⅝-inch webbing may be used, fitttings for the ½-inch and 1-inch webbing are more readily obtainable (at least in the Los Angeles

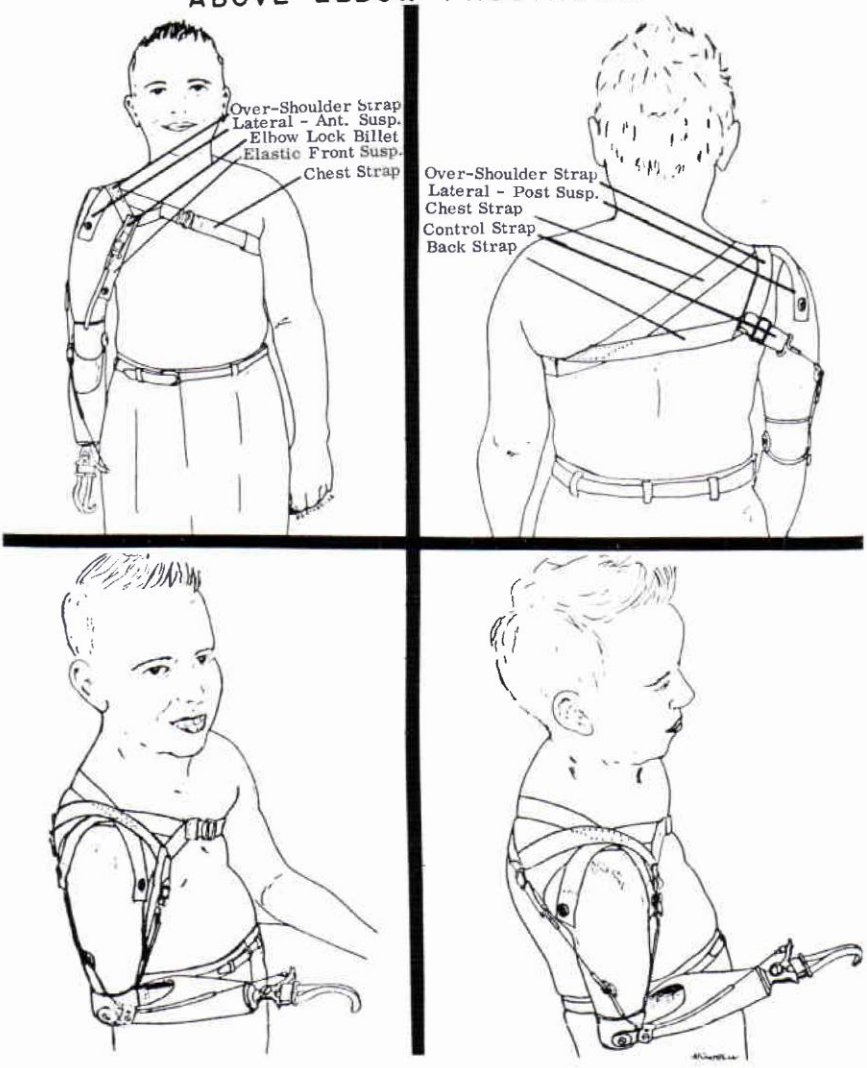
area) and their use has become standard practice at the Child Amputee Prosthetics Project.

Because the very young child (up to 18 months of age) has not developed skills involving any high degree of muscular coordination, he cannot be expected to operate the terminal device or the elbow lock actively. These devices are ordinarily operated by therapist, parent or by the child using his normal upper extremity.

Since the passively operated prosthesis has no control cable for terminal device operation, an elastic strap is used instead of the control attachment strap to maintain balance of the harness.

When the child has reached a point in his neuromuscular development

HARNESSING, ABOVE ELBOW PROSTHESIS



(20-30 months of age) where active operation of the terminal device can be expected, a control cable is added.

Because the amount of force and excursion possible at this age is very limited, the child generally cannot accomplish forearm flexion, and so a Bowden cable arrangment is applied. When the child develops sufficient force and excursion, the Bowden cable is exchanged for a standard above elbow cable mechanism. The elbow lock is generally activated at 24 to 36 months of age. At first the child may prefer to continue using the other hand, but with training usually becomes adept at active forearm flexion very quickly.

LETTER OF APPRECIATION RECEIVED FROM GERMANY

The following letter of thanks for a set of the two volumes of the Orthopaedic Atlas has been received at the Washington office of the Association:

"Dear Mr. Director Smith:

"On the occasion of the German Orthopaedic Congress at Weisbaden Mr. Porten handed over in behalf of your order two precious special books to the German Professional-Orthopaedic School.

"We are very glad to receive that present, which is a sign for a professional harmony. With many thanks we affirm that these books will not stay only in the bookcase, but will be used by our rising professional generation.

"We wish that the connection between the American and German orthopaedic branches and centres will be steady, in openmindedness and friendship. We thank you very much.

"We also would like to take this opportunity of asking you about the following matter:

"With great interest we have heard much of your work from Mr. Porten, especially about the admission of orthopaedic study by universities. It would be a great help for us in our endeavours, if you will kindly assist us by permitting us to study your corresponding education records and by informing us about the kinds of courses given. We are very interested in the structure, subjects, timetables, possibilities for diploma, and the teacher-team of your centre.

"It would be harder for us to start the same way; however, we would be very thinkful if we could learn by your education rules.

"On behalf of our managing committee, directors and co-workers we thank you for your cooperation,

Yours Very Truly,
Om. Uhlig, Leiter
Bundesfachschule