

## Technical Notes

# The Below-Elbow Inversion Harness

The below-elbow inversion harness (Fig. 1) is a modification of the conventional figure-eight harness, and is applicable in most cases

First: to stabilize the below-elbow socket against vertical loading as the elbow is extended by transmitting

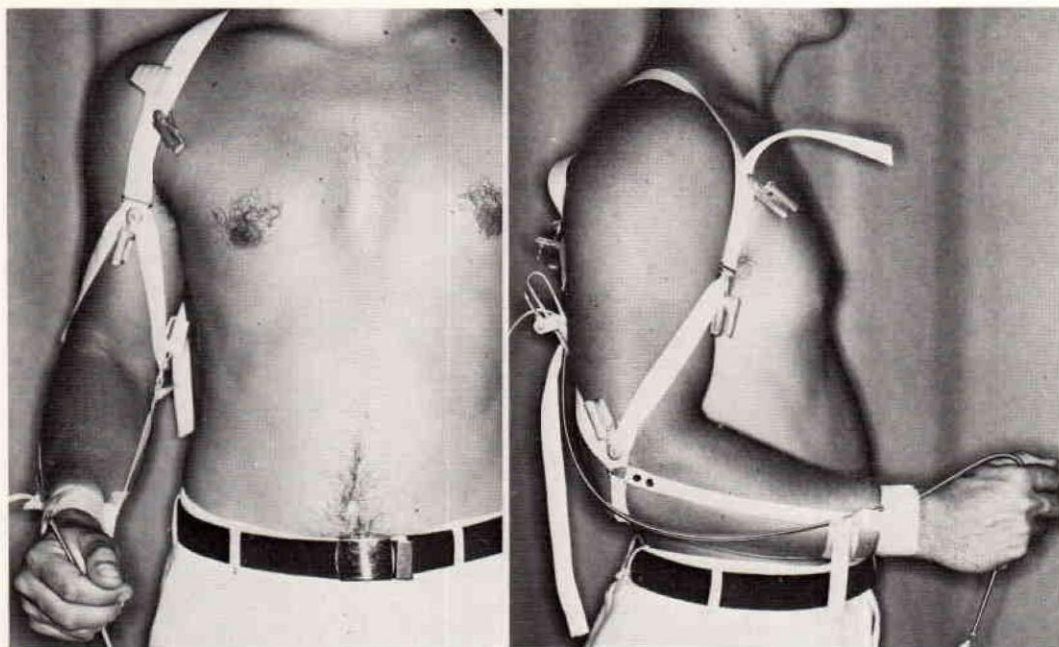


Fig. 1. The inversion harness laid up to demonstrate the principles involved.

where a conventional harness is prescribed. The triceps pad or cuff is eliminated, greater harness and socket stability are provided, and power transmission is more efficient. The inversion harness can be fabricated easier and in less time than the conventional. It is also more cosmetic and more durable. The various components of the inversion harness are shown in Figure 2.

The basic functional precepts of the below-elbow harness are not altered. Rather, the modification alters the means by which these precepts are realized.

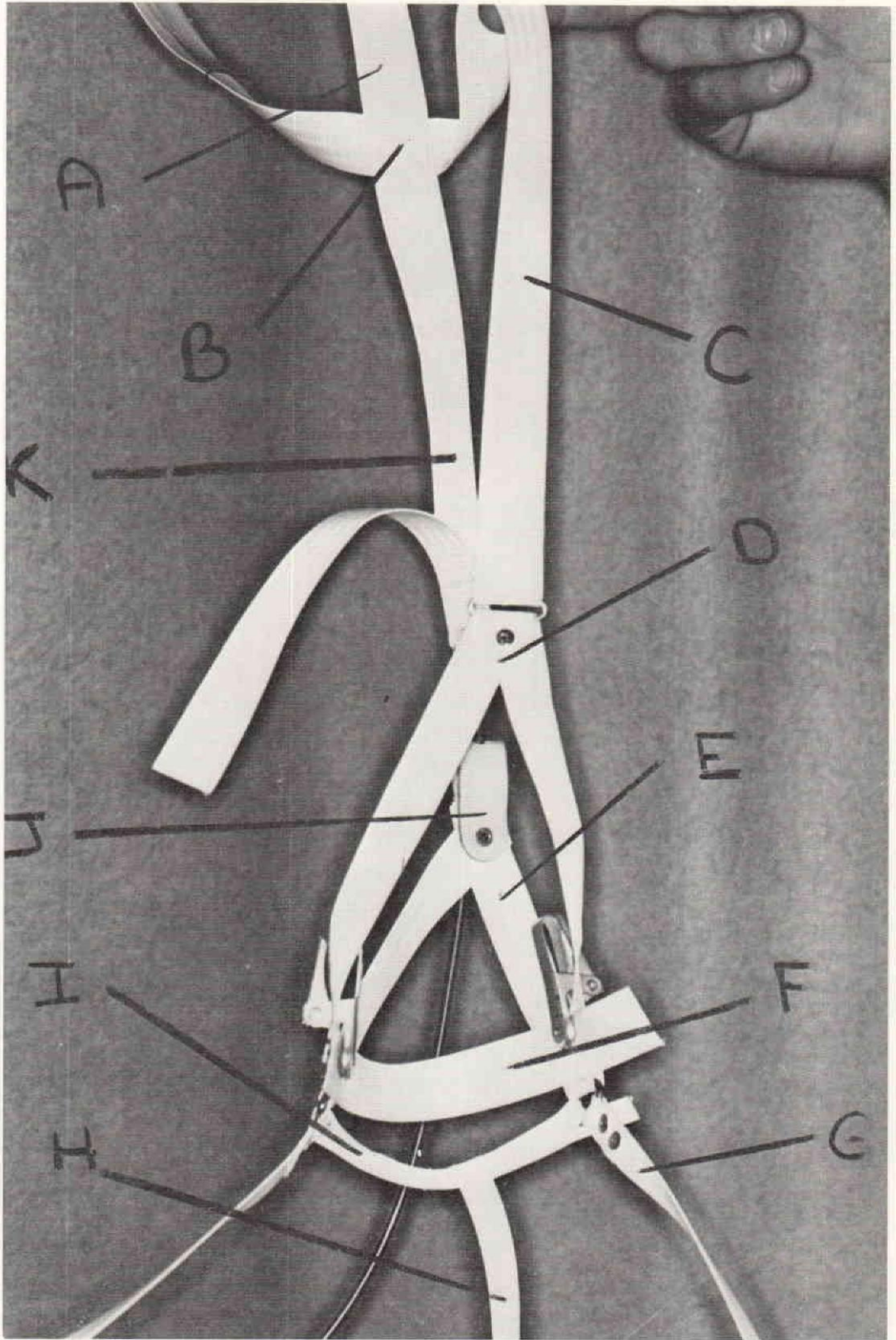
Before attempts are made to replace the triceps pad or cuff with a series of straps, the functional characteristic of the pad should be understood thoroughly. The function of the pad is basically threefold.

a counterforce from the anterior support strap to the flexible hinges.

Second: to stabilize the socket against a distally directed longitudinal force during elbow flexion by transmitting a counterforce from

Fig. 2. Parts of the Inversion Harness:

- A. Axillary Loop
- B. Harness cross
- C. Anterior Support Strap
- D. Inverted "Y"
- E. Inversion Strap
- F. Supra-olecranon strap
- G. Flexible hinges
- H. Anchor Strap (optional)
- I. Ulnar Strap
- J. Cross Bar Leather Loop
- K. Cable Control Strap



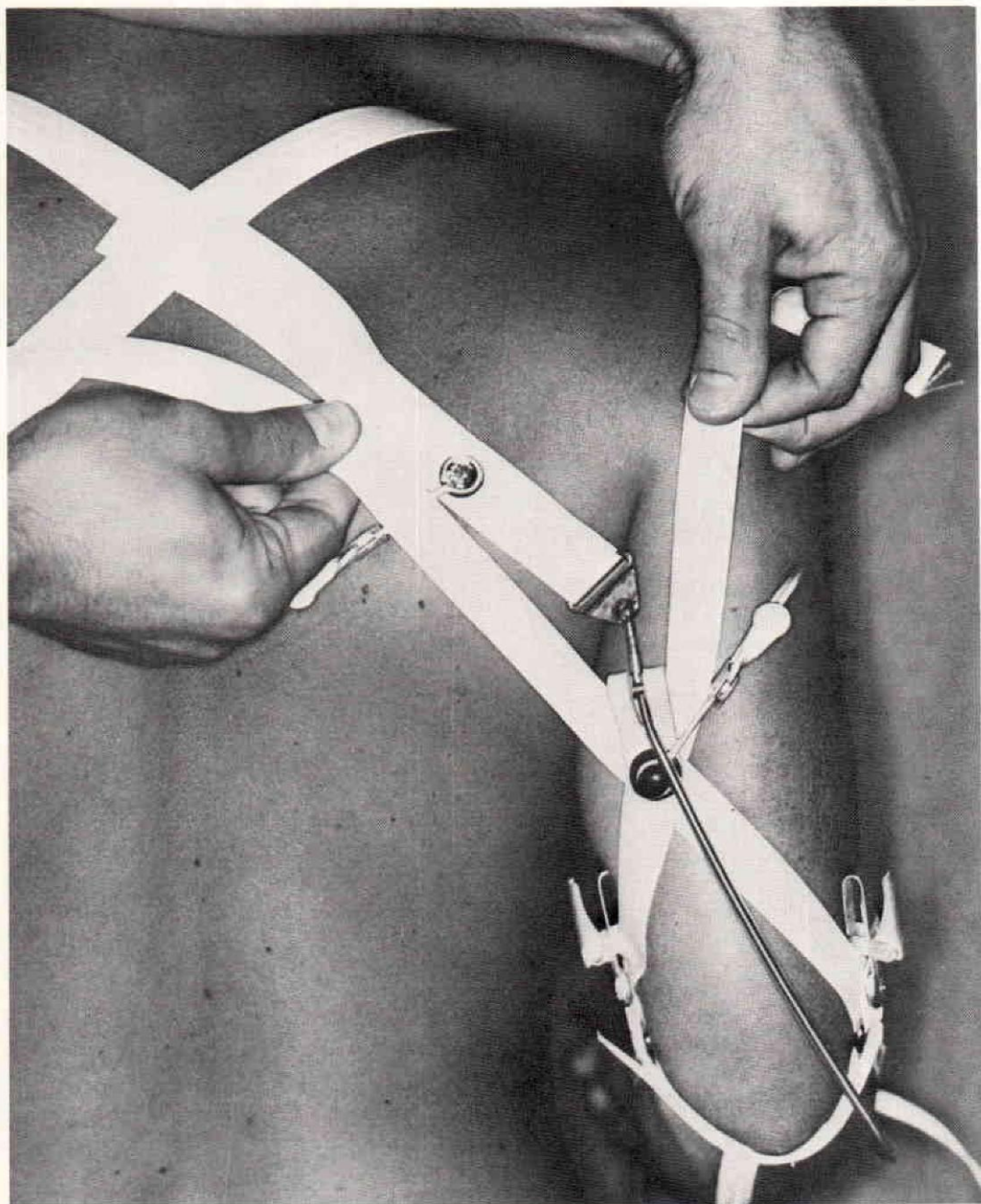


Fig. 3 Assembly of the posterior of the inversion harness.

the upper arm to the flexible hinges.

Third: to serve as a cable control reaction point by providing a location for the attachment of the cross-bar assembly.

These three functions of the pad are fully realized with the application of the below-elbow inversion harness. Vertical loading is

counteracted more efficiently by the linear continuum of the inverted "Y" strap and flexible hinges (D and G, Fig. 2), via the "D" rings. During elbow flexion, longitudinal forces are counteracted by the supraolecranon strap (F, Fig. 2). A base for attachment of the cable reaction point is provided by the intersection of the medial and lateral members of the inverted "Y" strap on the

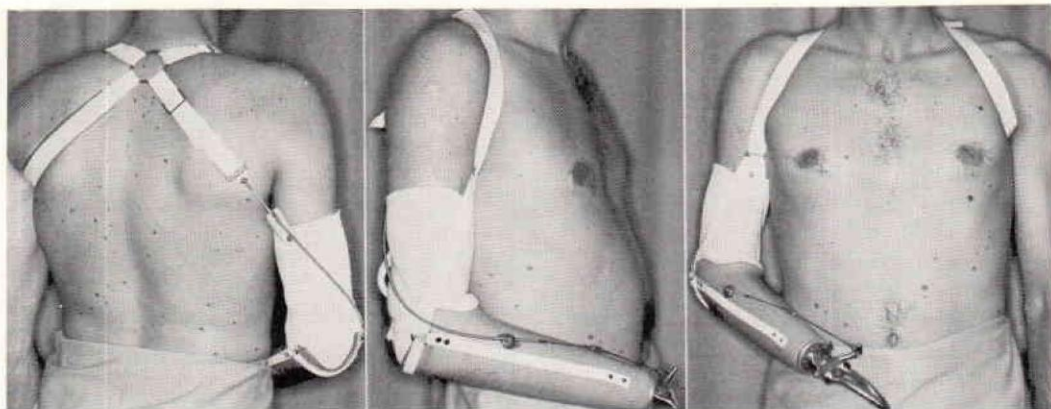


Fig. 4. Three views of the inversion harness.

posterior surface of the upper arm. Because all forces are transmitted through a balanced system, there is no buckling, chafing, or shifting of any of the harness components throughout the entire range of shoulder, elbow, and forearm motion.

#### FABRICATION

The first step is the preparation of the axillary loop, anterior support strap, and cable attachment strap in the conventional manner. Either the Northwestern ring or harness cross can be used. Insert a 4 ft. length of  $\frac{3}{4}$  in. dacron webbing through a four-bar buckle to the midway point. Permanently secure this strap just below the buckle with a divergent angle of about 30 degrees. The two diverging members will serve as the inverted "Y" strap (D, Fig. 2). Insert the two members through the  $\frac{5}{8}$  in. "D" ring to 8 in. of the four-bar buckle. Twist and invert these two members, and secure with a harness clamp just superior to the "D" rings (Fig. 2).

Permanently attach  $\frac{1}{2}$  in. dacron flexible hinges to the "D" rings with rivets (Fig. 2). The hinges should be about 14 in. long to facilitate attachment to the socket as distally as possible. The ulnar strap should be inserted through the "D" rings posterior to the flexible hinges, doubled over on itself, and clamped with a harness clamp. Finally, the supraolecranon strap (F, Fig. 2) should be cut about 6 in. long. In the final stages of fitting, the olecranon strap will be attached to the inverted strap immediately superior to the "D" rings.

#### FITTING

At this time, the harness, as well as the entire prosthesis (i. e., cable system, etc.) is ready for fitting. The countralateral arm

should be extended throughout the axillary loop. The anterior support strap should be attached for the four-bar buckle immediately superior to the belly of the biceps (Fig. 3). Flex the elbow to 90 degrees. Secure the flexible hinges with tape as far distally on the prosthesis as possible and adjust the ulnar strap so that the "D" rings coincide exactly with the humeral epicondyles (Fig. 3). From the back of the patient, draw the inversion straps through the "D" rings so that they will resist an equal amount of tension. Intersect these two straps at a point about  $1\frac{1}{2}$  in. below the middle of the arm. Secure the intersection as well as the cross bar leather loop with a harness clamp (Fig. 3). Secure the supracondylar strap to the inverted strap immediately above the "D" rings. Make sure that this strap provides the tension necessary to maintain properly the coincidence of the "D" rings and the humeral epicondyles.

The harness is now ready for final fitting. Attach all components of the cable system in the conventional manner (Fig. 4). Adjust all straps attached to the "D" rings in such a manner that the tension is equal, and there is no buckling.

Before removing the harness clamps for sewing, staple all strap unions, to insure that the harness is not altered during sewing. If the ulnar strap rides up and around the olecranon process, an anchor strap (H, Fig. 2) may be sewed to it and attached on the ulnar, distal side of the prosthesis.

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