

A WRIST-DRIVEN HAND PROSTHESIS

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INTRODUCTION

It is the authors' purpose to present a functional prosthesis, activated by wrist motion, designed for the patient who has sustained congenital or traumatic amputation of all digits including the thumb.

The concept is simple and is based on the use of the Engen "Reciprocal Wrist Extension-Finger Flexion Orthosis" (1) to open and close prosthetic fingers by action of the wrist stump. Since the Engen splint was originally fabricated to manipulate inactive flaccid fingers through the agency of an actively functioning wrist, it was a logical extension of this design to substitute prosthetic fingers in the case of a patient with total digital amputation, and to fit such fingers to the splint.

The type of amputation reported here is unusual as the result of trauma but is somewhat more frequently encountered as a birth defect. This prosthesis will, therefore, have a wider application for the congenital amputee (2,3) than for the traumatic amputee. By the very nature of our Center, where we treat veterans, we do not see congenital amputees. The prosthesis reported here was fabricated for a patient with post-traumatic amputation. In view of the rarity of this type of trauma, the following single case is reported:

CASE HISTORY

F.M., a 27-year-old stock broker, sustained shell-fragment wounds on June 4, 1968, resulting in multiple injuries, one feature of which was total amputation of all digits and metacarpals of the left hand, with only the proximal half of the thumb metacarpal remaining (Fig. 1). (Fig. 2 shows stump and previously worn cosmetic glove.) He was exam-



FIGURE 1.—X-ray showing total hand amputation except for proximal half of thumb metacarpal.

ined by the VAPC Clinic Team on December 23, 1971, because he was dissatisfied with his Robin-Aids hand that functioned via a harness with cable transmission. He found the unit to be extremely heavy and awkward and to be cosmetically unsatisfactory. Jentschura et al., have recommended that children with this lesion be fitted at 1½ years of age with an open-end plastic forearm with a hook attached over the extensor surface of the stump, activated via harness control (2). At the



FIGURE 2.—Amputation stump and passive cosmetic glove previously worn.

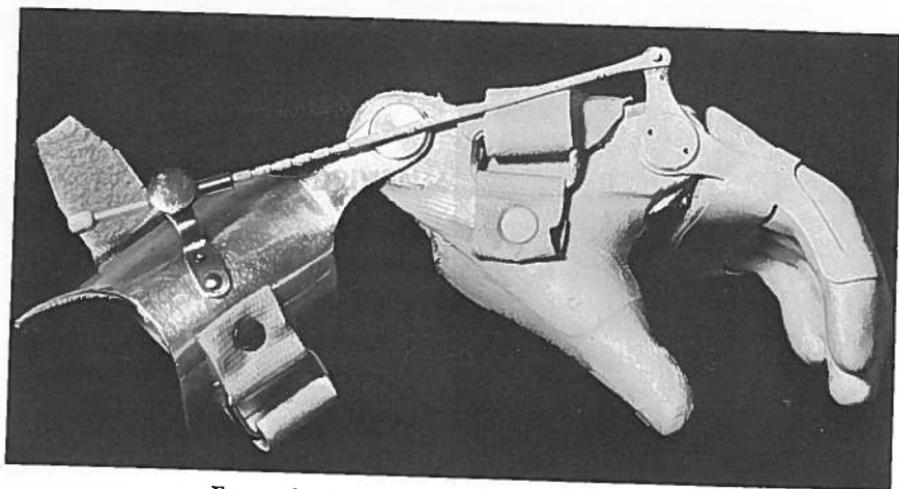


FIGURE 3.—The wrist-driven hand prosthesis.

VAPC Clinic Team meeting, two prosthetic approaches to the problem were outlined:

1. An attempt would be made to extend the thumb stump with a prosthesis to provide active opposition against a post. Since there was a distinct possibility that this might not succeed, a second course of action was outlined at the same time.
2. The Engen "Reciprocal Wrist Extension-Finger Flexion Orthosis" would be used in conjunction with prosthetic fingers.

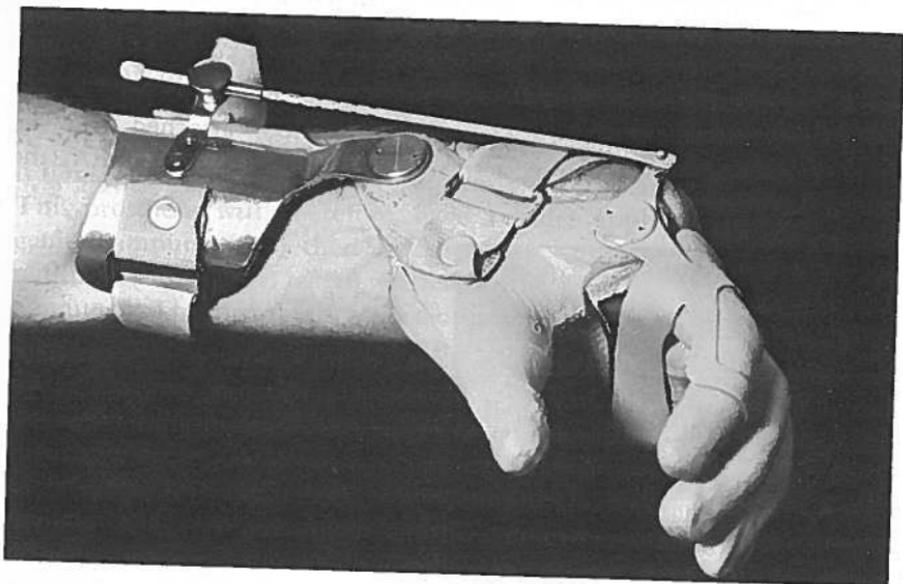


FIGURE 4.—Prosthesis fitted to patient. Wrist flexion opens the hand. Maximum opening capacity = $3\frac{3}{4}$ in.

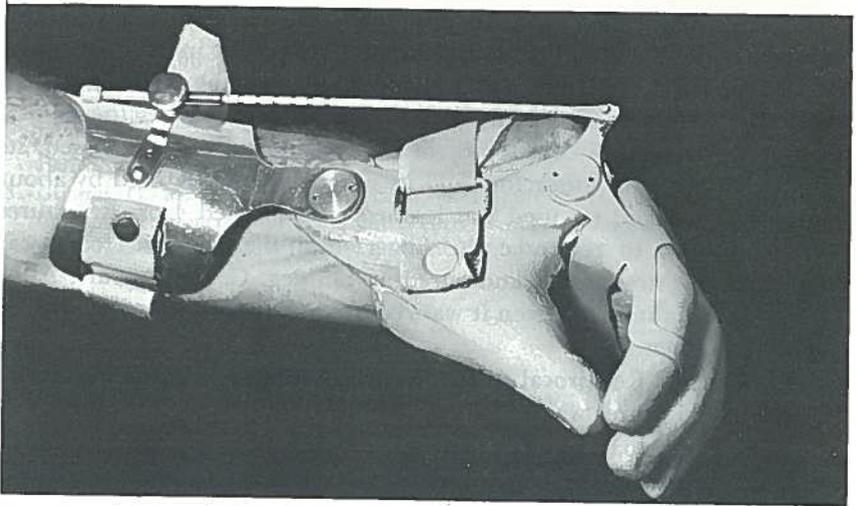


FIGURE 5.—Prosthesis fitted to patient. Wrist extension closes fingers in pinch position. Pinch force = 3 lb.

The first approach ended in failure. The second method was employed and the patient was fitted on August 21, 1972. He was given a short period of training and returned home to practice. Since the patient came to the VA Prosthetics Center from West Virginia, his visits were somewhat more widely spread than would be the case if he were locally situated. He performed well with this device and considered it cosmetically acceptable (Fig. 3, 4, and 5). The patient communicated with this office by telephone on August 24, 1972, and reported that he could pick up grapes and put them in his mouth, using the prosthetic hand, and that he could also separate and pull off stamps. He said that he was rapidly becoming proficient in the use of his new prosthesis.

On September 19, 1972, the patient returned for followup. He had been using the prosthesis constantly, and he demonstrated his ability to function with the device as indicated above, to hold large objects such as soda cans, and to hold a pencil or a sheet of paper. Measured pinch force was 3 lb. (A new design is under development which will enable the patient to accomplish pinch on wrist flexion rather than on extension. This will make use of the more powerful wrist flexors, as compared to the extensors, to increase pinch force significantly above the 3 lb. available with the present prosthesis.)

FABRICATION PROCEDURE

The two components of this device are:

1. A prosthetic hand
2. The Engen splint

The prosthetic hand can be prefabricated in several sizes. In this reported case the hand was individually prepared in a stone mold employing Parcloid 23-126 white foam.^a This could be made in a flesh color. If Parcloid is used in the density in which it reaches the laboratory, it will have the consistency of heavy rubber. If it is foamed, its consistency remains satisfactory and its weight will be reduced by about one-half. The hand we used was foamed and weighed 4 oz. Armatures were employed to reinforce the fingers and the Parcloid foam was poured into a stone mold and cured at 135 deg. C. for 3 hours. After cooling overnight in the oven it was removed. A thumb was prepared in the same manner.

The Engen "Reciprocal Wrist Extension-Finger Flexion Orthosis" was modified in three ways:

1. The metal band and Velcro strap controlling the middle finger were removed from the basic orthosis. Since the entire prosthetic hand is a unit, the Engen splint attachment to the index finger is sufficient to control movement of the total hand (Fig. 4 and 5).

2. The previously prepared prosthetic thumb was laminated to the splint (Fig. 4 and 5).

3. A 1/2 in. stainless-steel band was fitted to the volar proximal prosthetic hand (Fig. 4 and 5) to serve as a point of attachment for the ulnar joint. The band was brazed to the Engen splint on the radial side.

FUNCTION OF THE PROSTHESIS

The prosthesis functions in a manner similar to the well-known mode of action of the Engen splint (1); i.e., dorsiflexion of the wrist closes the index finger against the thumb, and volar flexion opens the fingers.

SUMMARY

A functional splint has been presented which is wrist-driven and is a useful device for the total-hand amputee with an active wrist stump.

ACKNOWLEDGMENT

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^a Parcloid Chemical Co., 140 Greenwood Avenue, Midland Park, N.J. 07432.

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