A Review of the Failures In Use of the Below Elbow Myoelectric Prosthesis

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INTRODUCTION

The myoelectric program at the Ontario Workmen's Compensation Board Hospital and Rehabilitation Centre started in the middle 1970's. The "Russian Arm" from the Rehabilitation Institute of Montreal (RIM) was used initially, and now the Otto Bock 6 volt system (117 patients) is used predominantly. The total number of below elbow myoelectric fittings as of September, 1981 was 128. Each patient is fitted with a cable-operated prosthesis with a hook and hand and continues to possess and use this prosthesis after being fitted with the myoelectric prosthesis.

Our early experience was previously reported in the *Journal of Bone and Joint Surgery*.[2] A number of patients have subsequently been found to either use the myoelectric prosthesis on rare occasions only or have rejected it. A review of this small group of patients was undertaken in order to determine why these patients did not use their prosthesis, and to hopefully provide us with information to predict unsuccessful users and, therefore, contraindications to fitting a below elbow amputee with an expensive myoelectric prosthesis.

MATERIAL AND METHODS

Twenty-five out of 128 patients who had been fitted with the below elbow myoelectric prosthesis were included in this review. Five of these patients had voluntarily returned their myoelectric prosthesis; 14 had indicated rejection or limited use of the prosthesis at follow-up Amputee Clinic Reviews and six had failed to return for review following supply of the prosthesis.

Twenty-two of 25 patients were reviewed with a mean follow-up time between myoelectric fitting and review of 33 months, (range of 2 to 57 months). The remaining three patients could not be contacted.

A standardized questionnaire was used in a personal or telephone interview with each patient, which evaluated the functional use of the myoelectric prosthesis in activities of daily living, vocational and avocational areas, and of the amputee's degree of acceptance in terms of function, cosmesis and comfort. The amount of time during which the prosthesis was actually

worn was asked, its use and reliability were assessed, and the problems the patient encountered with the prosthesis were investigated. As each patient possesses both the cable-operated and myoelectric prostheses, a comparison was made between the two. Interpretation of the results is necessarily guarded because of the small sample of 22 patients.

RESULTS

The mean age at the time of review was 41 years, the oldest patient was 67 and the youngest 29. Six patients were bilateral and 16 were unilateral below elbow amputees. The dominant side was injured in 63 per cent of the cases. Twenty-one patients were male and one was female.

The patients were divided into two groups; one group (ten patients) defined as limited users, wore their myoelectric prosthesis infrequently. The other group (12 patients) defined as non-users, were not wearing the myoelectric arm.

PROSTHESIS WEAR AND USE

Data was collected by asking each group of patients the number of hours they wore each prosthesis on an average day during the week and on the weekend (Tables I and II). Of the group of ten limited users, all wore the myoelectric prosthesis on the weekend; although the frequency and amount of time varied a great deal during the week, based to a large extent on their social activities.

The 12 non-users had completely rejected the myoelectric prosthesis, indicating a rejection rate of 9 per cent. This figure is compatible with the rejection rate of 8 per cent for the population of 59 Workmen's Compensation Board amputees previously studied by Northmore-Ball et al (1980). In comparison, the Swedish study of trained and untrained amputees reported by Herberts et al (1980) indicated a rejection rate of 44 per cent and 77 per cent respectively.[1]

The patients were used as their own controls and were asked to answer from memory the same questions for the time period before they were fitted with their myoelectric hand (Tables III and IV).

During the week, the time the hook was used remained relatively constant for both groups. On the weekend, while the hook use remained constant for the non-users of myoelectric prostheses, there was a decrease for the limited users, which indicated they were now using the myoelectric prosthesis for some of the time instead of the hook.

The mechanical hand appears to have been seldom used, except on social occasions, and with the advent of the electric hand, it appears to have become obsolete.

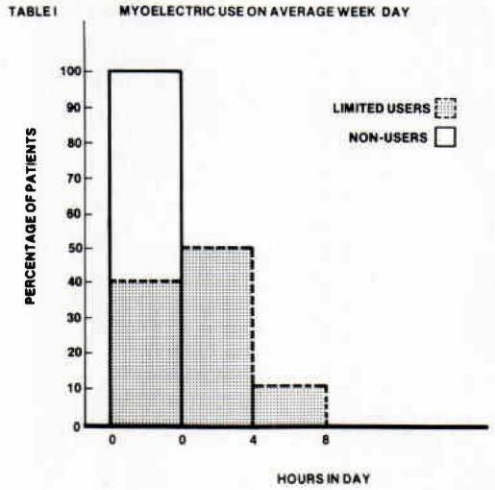
Several factors possibly affecting the patient's use of the electric hand were investigated, and the factors that were significant were type of job and leisure activities, the daily needs of bilateral amputees and the need for a cosmetically acceptable and comfortable prosthesis.

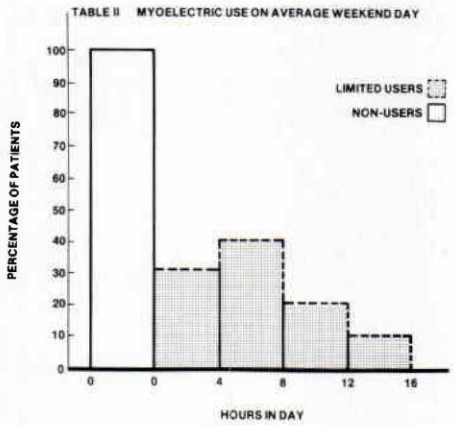
VOCATIONAL USE

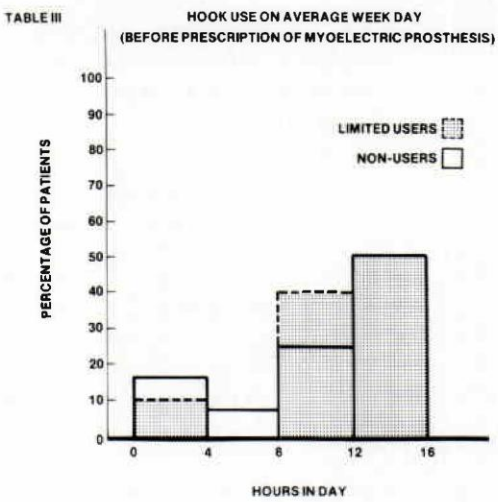
Although there was 100 per cent rejection of the myoelectric prosthesis at the work site by both groups, 84 per cent of the patients used their hook at work. The following factors determined the criteria for not using the myoelectric prosthesis at work: the cleanliness of the work environment, the manipulative skill required in handling tools, the force required to lift and carry heavy objects, and the degree of exposure to the public. The previous study by Northmore-Ball et al[2] confirmed that those patients who used the electric hand predominantly at work tended to have office type jobs. Most of the patients in both our groups were unable to use their prosthesis because of the physical demands of their jobs as mentioned.

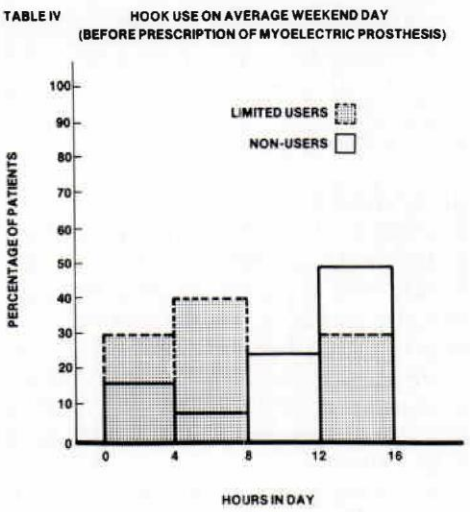
RECREATIONAL USE

All the limited users indicated that the prosthesis was useful at social events, i.e. eating, drinking and carrying light objects. This group places a high cosmetic value on the myoelectric prosthesis when in contact with the public. Although half the patients wore their myoelectric prosthesis passively, they commented that the possibility of using the prosthesis functionally was important to them in a social setting.









BILATERAL BELOW ELBOW AMPUTEES

All six of the bilateral amputees in the myoelectric program fell into the group under study; two were in the group of limited users and four in the non-users' group. Two were supplied with electric wrist rotators, one in each group. Bilateral amputees require a high level of function from their prostheses, and all overwhelmingly indicated that because the myoelectric prosthesis had very little functional value for them, they preferred to use their hooks. They complained about a lack of precision with two myoelectric hands which was possible with two hooks. To provide bilateral below elbow amputees with a more functionally valuable prosthesis requires further evaluation of wrist rotators and the myoelectric hook.

Figure 1—Comparison of large male hand and myoelectric hand demonstrates need for larger hand size.

COSMESIS

Eighty per cent of the limited users expressed a strong concern with cosmesis; whereas only about 33 per cent of the non-users expressed a similar concern. The group of non-users were comfortable with their hooks in public, and even felt that the hook was as good looking as the myoelectric hand. The majority of patients felt that the myoelectric prosthesis was acceptable to the public and to their families, but a few were dissatisfied with the color of the glove and some patients were dissatisfied with the small size of the hand. They felt that its smaller size in comparison with their own larger hand made it appear "feminine". At present, the standard sizes of the adult myoelectric hand are seven and one-quarter inches (18.4 cm.) and seven and three-quarter inches (19.7 cm.). There is an obvious need for a larger hand to better approximate the hand sizes in most men, which average eight to eight and a half inches (21.6 cm.) (Fig. 1).

Two patients with a transcarpal amputation requested a myoelectric prosthesis. In order to allow room to accommodate the prosthetic components, they had to be fitted with a prosthesis that resulted in a considerable length of discrepancy. It becomes evident that a suitable level of amputation is necessary to achieve good cosmesis (Fig. 2).

COMFORT

More than half of the patients of each group were very aware of the weight of the myoelectric prosthesis and its tiring effect. Although the actual difference in weight between the two types of prostheses is small (Table V), the weight is accentuated by the suspension used in the myoelectric prosthesis. To anticipate this problem of weight intolerance, a preliminary check with a weighted socket may be indicated for some patients.

Approximately three-quarters of the limited users and non-users complained of discomfort in the elbow area. Close ques-

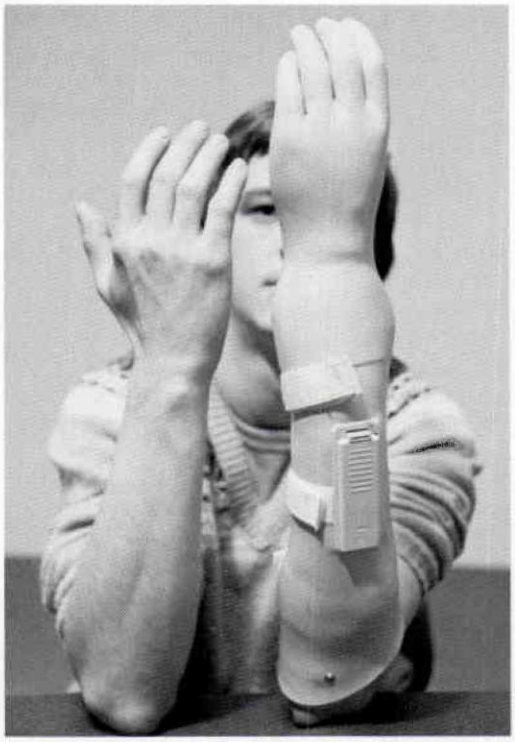


Figure 2—Unsatisfactory appearance of transmetacarpal amputation fitted with myoelectric prosthesis.

tioning of the patients, however, revealed that the discomfort in this specific area did not appear to be a key factor in their rejection of the myoelectric prosthesis.

Although three-quarters of the patients in both groups stated they did not mind the harness of their cable-operated prosthesis, most of the limited users preferred the comfort of the myoelectric prosthesis because of the absence of a harness.

REASONS FOR NON-USE AND REJECTION

For the limited users, the most common reason for not using the myoelectric hand at work, home or during leisure activities was fear of damaging either the prosthesis itself or its cosmetic glove. Approximately half the patients found that the glove was much too easily torn or cut, while almost all of them found that it could be easily ruined by grease, newsprint, ball point ink, carbon paper and wet blue jeans.

Another reason for non-use was instability of the socket for heavy work due primarily to the type of suspension used. The Muenster socket requires particularly skillful fitting and any fluctuations in

TABLE V

COMPARATIVE WEIGHTS OF UPPER LIMB PROSTHESES

CABLE OPERATED PROSTHESIS	
CABLE OPERATED (STANDARD) BELOW ELBOW PROSTHESIS WITH STAINLESS STEEL HOOK (DORRANCE NO. 5)	2 LB. (908 gm.)
CABLE OPERATED (STANDARD) BELOW ELBOW PROSTHESIS WITH MECHANICAL HAND	2 LB. 7 OZ. (1107 gm.)
MECHANICAL HOOK (SPLIT HOOK)	7 - 13 OZ. (198 - 368 gm.)
MECHANICAL HAND (DORRANCE NO. 4)	1 LB. 2.5 OZ. (525 gm.)
MYOELECTRIC PROSTHESIS	
COMPLETE BELOW ELBOW MYOELECTRIC PROSTHESIS WITH MYOELECTRIC HAND	2 LB. 6 OZ. (1078 gm.)
COMPLETE BELOW ELBOW MYOELECTRIC PROSTHESIS WITH MYOELECTRIC HOOK	2 LB. 5 OZ. (1050 gm.)
MYOELECTRIC HAND	1 LB. 3.5 OZ. (553 gm.)
MYOELECTRIC HOOK	1 LB. 2.5 OZ. (525 gm.)
WITH ELECTRIC WRIST ROTATION UNIT - ADD	5.1 OZ. (145 gm.)

residual limb size will affect the socket fit and may cause instability.

The reason given most frequently for rejection of the myoelectric prosthesis by the group of 12 non-users was its poor functional value. These patients were especially happy with the precision of the hook and the strength of the cable-operated prosthesis for heavy work. They found the prosthesis comfortable, did not mind the harness and did not have a strong cosmetic need. This may, in part, be due to the fact that one-third of the non-users were bilateral amputees.

CONCLUSIONS

It is our policy to give below elbow amputees the opportunity to be fitted with a myoelectric prosthesis six to twelve months after the injury, and we have come to realize that amputees will use both the hook and the myoelectric prosthesis for various purposes, rather than one prosthesis exclusively.

As a result of this review, the following are now used as relative contraindications to fitting a below elbow amputee with a myoelectric prosthesis:

- Bilateral below elbow amputation,
- Lack of concern with the cosmetic appearance of a hook or the discomfort of a harness,
- Requirement of a prosthesis with strength, precision and durability at work or leisure,
- Too long a residual limb (transcarpal/metacarpal amputation) unless the amputee is prepared to undergo revision surgery so that a prosthesis of satisfactory length can be fitted.

Acceptance of aids by the handicapped is a very complex process in which individual psychological, technical and socio-economic factors interact. Almost all of our reviewed patients had accepted the standard prosthesis and used it at work, home and in leisure activities. The fact that all these myoelectric non-users still use a hook would suggest that their rejection of the myoelectric prosthesis is based on limitations of the prosthesis, rather than the psychological influences of a device for the handicapped.

The myoelectric hook may prove to be the solution for those patients who find that the myoelectric hand does not provide them with enough function to be of value.

REFERENCES

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