EVOLUTION OF THE BIOELECTRICAL ARM PROSTHESIS SYSTEM

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Summary

During the past five years the relation between patient, prosthesis and environment in the field of bioelectrical arm prostheses have been studied. The harmony between these three factors determines the indication of bioprosthetic fitting of the patient and guarantees maximum practical use.

Since 1966 we have been fitting patients with bioelectrical arm prostheses. Follow-up examinations will complete our experiences. Our main concern has been the relation between patient, prosthesis, and environment, with less emphasis on the technical aspects.

We have tried to analyse the three factors as follows:

1. The Patient

Consideration must be given to:

The amputation stump,

The patient's occupation,

The patient's learning capacity, and

The personality of the patient.

(1) *The Amputation Stump*

The muscle of the amputation stump should have tied to the distal ends of the bone;

it must be possible to innervate the antagonists separately; and

the elbow and shoulder joints must be freely movable.

There should be no rough scars in the tissue where the electrodes are to be placed. Stump and tissue must have the capacity of carrying a prosthesis.

Stumps with a disturbed blood supply are not suited. Excessive perspiration can be a handicap. Krukenberg stumps are not suited for bioprostheses.

Muscle training should show good results.

(2) *The Patient's Occupation*

The occupation, i.e. the work done should be an organisational or mental nature. Amputees with predominantly heavy manual work should not be fitted with this kind of system. These patients are better fitted with a body-powered prosthesis with a hook.

In general we found that, after amputation, our patients changed their occupation and from primarily manual work to organisational or mental work. This change could be reached either by further education or by retraining. Hence, for the major part of the amputees a bioelectrically controlled prosthesis is acceptable in regard to their occupation.

(3) *The Patient's Learning Capacity*

The patient's capacity to learn is a most essential element in success.

We could state that even patients who had been amputated 25 years ago and who were fitted with a bioelectrical prosthesis for the first time learnt how to operate it by controlling their muscles. To operate a prosthesis efficiently, however, requires more than merely innervating agonists and antagonists. The prosthesis must become an integral part of the amputee.

Controlling the prosthesis should be performed with as little concentration as possible to avoid getting tired. Learning how to operate it lies between conditioned reflex and association. Patients who have a certain degree of technical understanding and the ability to learn new patterns of movements will encounter little difficulty.

These two factors are of especial importance when it comes to controlling more operations than simply opening and closing the hand. Here, logic and physiological control systems which require little concentration have to employed to avoid getting tired. Patients who have not lost their arms by amputation but in cases where one or even both arms are missing due to a congenital deformity have to be treated carefully physiotherapeutically, both before and after having been provided with a prosthesis, and must be induced to develop movement patterns by practising with it.

We have seen this in patients with a deformity who did not get the prosthesis during their childhood but during adolescence. they were accustomed to being one-handed and used the bioprosthesis merely as a cosmetic arm.

(4) *The Personality of the Patient*

Active, optimistic people of stable emotional behaviour, with a matter-of-fact and self controlled approach, who are prepared to co-operate, are best suited for being fitted with a prosthesis. Patients of weak concertration, those who are nervous or inflexible and inelastic with low "adaptibility" are better not supplied with this kind of prosthesis.

The intelligence quotient is not so important. Practically-minded patients with some technical understanding are particularly suited for the bioelectric prosthesis.

2. The Prosthesis

Physiological coupling plays an essential role in the integration of the system. The well-modelled and properly fitted prosthetic forearm and arm are not only significant for the functioning of the bioprosthesis but also have a positive psychological effect. The inevitable socked-stump pseudoarthrosis should be reduced as much as possible.

For the amputee the prosthesis is in the center of all considerations. Its practical value is composed of its objective properties and the individual facilities it offers the respective patient.

Among these objective qualities are:

(1) Physiological coupling
The socket must guarantee safe and easy operation of the prosthesis with a minimum pseudoarthrosis effect and it should be without harness.

(2) Logic controlling is essential in order to enable operation requiring little concentration, particularly with multifunctional prostheses, and to reduce the learning process to a minimum.

(3) Easy donning and wearing of the prosthesis is important.

(4) Highly efficient function and first-class cosmetic, safe functioning, and easy up-keep are mandatory requirements of any good prosthesis.

The individual possibilities are variable. Emphasis is to be put on the close connection between amputee and prosthesis. The objective properties of prostheses should tally with the individual requirements, i.e. the amputee should be fully conversant

with the facilities offered and also with the limits of this kind of fitting. Only in this way will it be possible to achieve a unity between patient and prosthesis.

3.Environment

Environmental conditions have no small bearing on the successful fitting of the amputee. We know the patients and their immediate environment which comprises family, friends, dwelling, and job. To a certain extent the immediate environment is adaptable to the circumstances the patient is in. However, the remaining environmental factors are not adaptable. In the anonymity of a modern mass society personal requirements tend to be neglected.

The amputee's situation in a town differs basically from that in a village. The amputee has to cope with these circumstances and try to find his place in his environment. For strong personalities adaptation will be less difficult.

4. Conclusion

To summarize, that the three factors patient, prosthesis, and anvironment must be interrelated harmoniously in order to achieve maximum results. All of these factors should be taken into consideration when deciding upon the indication of a bioelectrically controlled prosthesis. Rehabilitation and integration of these patients depends largely on these factors.

The bioelectrical prosthesis system is the only one to transmit a muscular signal from the signal source to the prosthetic limb without mechanical reaction. The advantage of physiological direct coupling promotes the integration of man and prosthesis thus providing this kind of fitting with a high practical value. Contrasting opinions offered by amputees concerning the practical value of bioelectrically controlled prostheses are partly due to the fact that the above aspects have not been considered, adequately.

Apart from the physiotherapeutical training of the patients, early assistance must be rendered to the psychological and mental development begining with instruction of the patient and continuing to the constant consultation in terms of an approach to independence.