THE MAIN PRINCIPLES OF REHABILITATION OF THE DISABLED WITH UPPER EXTREMITIES DEFECTS

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One of the most important aims of prosthetics as a means of social-labour rehabilitation is the maintenance of possibilities for the disabled to take part in labour for the benefit of society.

The restoring effectiveness of the lost functions of the upper extremities with the help of technical means is determined both by the quality level of the prosthetic-orthopaedic wares and by the preparedness of the disabled to use the prosthetic applicances.

Besides the whole complex of curative, psycho-physiotherapeutic, and if necessary surgical measures, the process of preparing the disabled for prosthetics includes acquiring of control skills of the prescribed prosthetic appliance and mastering the skills to operate such appliance.

Modernization of existing and development of new high-quality prosthetic appliances of the upper extremities put forward new and higher requirements for preparing and training of the disabled to use such prosthetic appliances. Preparing and traning of the disabled is one of the main stages of prosthetics and its character influences to a large extent the final result i.e. rehabilitation.

At present in prosthetics of the disabled with amputated upper extremities bioelectrical prosthetic appliances are considered the most perspective them having great advantages as compared to other disings. The operating of such prosthetic appliance is close to the healthy upper extremity natural control and it partially restore conditioned-reflex connections lost after amputation. The usage of bioelectrical prosthetic appliance normalizes the stump tissue condition, improves blood circulation, metabolisme etc.

The bioelectrical proportional control prosthetic appliances possess the highest functional as compared with the other existing models of bielectrical prosthetic appliances. This can be proved by the fact that the natural movements of man have smooth (proportional) rate control of the joints and the efforts exerted.

In prosthetics practice the rposthetic appliances of the forearms with bioelectrical propotional control of hand-catch and hand-opening are widely used. The functional diagram of this prosthetic appliance is represented in the figure 1.

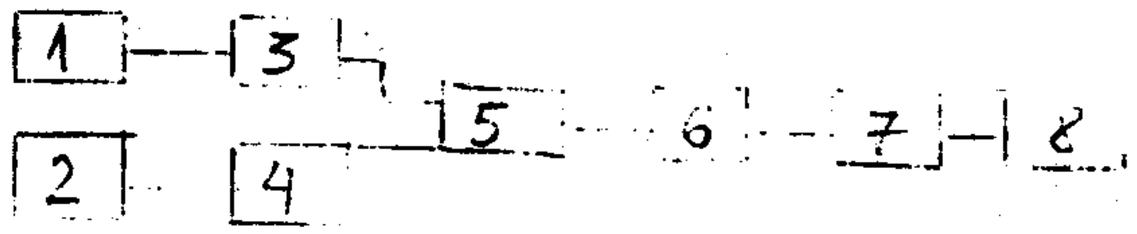

Fig. 1. Functional diagram of the forearm prosthetic appliance with bioelectrical proportional control of hand-catch and hand-opening.

The control system operates in the following way. Bioelectrical signals coming from control muscles with the help of superficial

bipolar electrodes I,2 with built-in preliminary amplifiers, enter the amplitude defectors 3,4, with low-frequency filters. At the outputs of the defectors circumflex bioelectrical signals of opposite polarity are formed which enter the imput of comparison scheme 5 where their algebraic summing up takes place.

At the output of the comparison circuit a direct current signal is formed, its magnitude being proportional to the ones of convertex biopotential chnnels of hand-catch and hand-opening. The polarity is to be determined by the larger absolute value of convertex biopotentias.

Then direct current signal varying by magnitude enters the converter 6, which forms a pulse signal, its frequency and duration changing proportionally to ymplitude of the imput signal.

From the converter output the pulse signal enters the bridge power amplifier 7, its diagonal being connected with the hand electric drive 8.

The disabled are supposed to have skills to operate such prosthetic appliances and these skills are aquired in the process of training.

Practice of prosthetic with bioelectrical prosthetic appliances proves their advantages not to be used to their full extent. Their effectiveness decreases their due to the imperfect means of preparing the disabled to operate such prosthetic appliances at prosthetic-orthopaedic workshops.

When training the disabled to operate prosthetic appliance with different control system the general task should be to check up and if necessary to develop control muscles activity to an extent allowing to operate one of the prosthetic appliances. Particular tasks may be set i.e. to develop antagonist muscles separate contraction skills to develop skills of smooth dosing bioelectrical muscular activity control. All this is gained by accomplishing a certain motor act.

There are some special methods for developing some of the motor actions needed for disabled to be prepared for prosthetics.

For this purpose the bioelectrical prosthetic cabinets are supplied with special equipment: two power amplifiers with performance identical to that of bioelectrical prosthetic appliances, but having adjustable coefficient of amplification; two electrodes connected with amplifiers imputs, registering devices connected with amplifiers outputs; a sinusoidal signals generator for calibrating this device; a model of bioelectrical prosthetic appliance. This eqipment is used both for the purpose of determining the preparedness level of the disabled for bioelectrical prosthetics and for training the disabled to develop necessary control muscles activity and their separate contractions.

At the begining of training the disabled, tries to control muscular electric activity and separation of muscles contraction according to control instrument ridings after that he checks up what he gained during training by operating the prosthetic appliance model guiding his actions by muscular-articualar sense.

A special device has been worked out for training the operator and for investigation of prosthetic appliance bioelectrical operating dynamics. This device helps in preparing the disabled to operate the proportional bioelectrical prosthetic appliance.

The training principle is the following: the disabled controls the beam on the screen of the electron-optical indicator dosing the electrical activity of the two muscles by using blocks of implification and circumflex discharge.

The operator can acquire skills of dosed control bioelectrical muscular activity as a result of training. The ability of the disabled to control the beam on the indicator screen in any given direction confirms this fact. Thus the disabled acquires the skills to control the prosthetic appliance with the help of two muscles.

At prosthetic-orthopaedic workshops the preparation for proportional bioelectrical control should be as close to real conditions of prosthetic appliance bioelectrical control as possible. This preparation should include electrical muscular activity measurement and control. Besides, this method should give the possibility for the disabled to master the the skills of bioelectrical control with the help of prosthetic appliance model and to measure the most important range of pilot signal within the given dynamic range and the range itself; and dynamic correlation of antagonist muscles electrical activity after control skills have been acquired.

Taking into account everything said, methods of preparing the disabled to use bioelectrical prosthetic appliances have been worked out the plant for preparing the disabled to operate bioelectrical prosthetic appliance (fig.I) being the basis of these methods. This plant consists of the following functional assemblies: bipolar superficial electrodes; diopotential amplifiers with controlled coefficient of amplification, calibrator, bioelectrical muscular activity gauge, control range gauge, artificial hend with electrodive and stabilized feed source (fig.2).

These methods give the following possibilities:

1. To measure the electrical muscular activity, to find out the control muscles.
2. To measure the highest possible electrical activity of control muscle and it antagonist one.
3. To determine the point when the appliance model starts working powered by natural electrical activity of control muscle depending on antagonist one activity.
4. To control the pilot signal magnitude within the given dynamic range of the control system with separate and joint activity of antagonist muscles.
5. To increase the electrical activity of control muscles.
6. To acquire the skills to operate the prosthetic appliance model with the established combinations of muscular activity and the ability to vary these combinations activity.
7. To vary the antagonist electrical activity and the pilot signal magnitude in the given dynamic range while moving the artificial appliance model artificial hand.
8. To determine the physical difficulaties of prosthetic appliance model control.
9. To acquire the skills of smooth (proportional) control of seize strength as well as the rate of artificial hand fingers.

The most important stage in preparing the disabled to use upper extremities prosthetic appliances is to teach the disabled to operate the given prosthetic appliance. For this purpose the disabled having been trained to put on the prosthetic appliance and to operate it si taught to accomplish some specific movements every day and labour operations and also to acquire a havit of self - service with the help of stands and methods of training worked out by USSR.

The methods and stand worked out by USSR were meant for prosthetic-orthopaedic workshops.

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These methods of training give the following possibilities:

a) to use the functional possibilities of prosthetic appliance to their full extent;
b) to make the process of training more active;
c) to determine the preparedness level of the disabled to operate the upper extreminites prosthetic appliances.

According to USSR methods the trainig process is devided into the following stages:

1. to train accomplishing separete operations;
2. to train accomplishing combined operations;
3. a training stabilization period;
4. a training automatic period;

These methods allow to determine:

1. duration of separate operations;
2. the durations of combine operations, before and after training;
3. the number of mistakes while working with trinometer before and after training;
4. the smoothness of dosing efforts;
5. the duration of rate control of fingers movement;
6. the preparedness level of the disabled to accomplish operations on the stand.

The preparedness degree is determined by the proportion of complex operations duration on the stand by upper extremity of the healthy man to that of upper extremity prosthetic appliance of the disabled during movements automation (fig.3).

In process of training the stand is used which stands such functional possibilities of prosthetic appliance as:

- side translational movements;
- streight translational movements;
- rotary movements;
- smooth dosing of seize-strength;
- the smooth rate control of fingers movements;
- the ability to control the prosthetic appliance movements;
- the ability to handle the articles different in weight, size, form and nature surface and located at different places;
- the ability to find out the objects;
- the ability to accomplish some labour operations (i.e. to use a screw driver, to draw, to sew etc);
- the ability to accomplish everyday operations (to switch on and off the light, radio, TV-set, to use the door key etc.)
- the accomplishing of self-services (to take meal, drink, shave, comb, brush the feeth etc.)

The disabled will be considered trained provided he accomplishes certain operations on the stand for the minimum time and with minimum number of mistakes.