BIOELECTRICAL UPPER-LIMB PROSTHESIS FOR CHILDREN

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Children´s prosthetics is an important problem, both medical and social, the solvation of which rehabilitates the functioning of the lost extremity, prevents the development of the secondary deformations and contributes to more harmonic development of the child.

Latest ten years we have observed the tendency towards the considerable increase in the number of children with developmental anomaly of the limbs what makes it necessary to provide them with prosthesis at an early age.

The question about the necessity of using external power-sources in children´s prosthetics has been solved according to the unanimous opinion of the specialists as positively; however, other problems have become more acute, such as: what kind must be the power source of and what control methods must be used? The search of new and mostly rational ways in the children´s upper-limb prosthesis building is highly urgent. One of the most important tasks is to provide high functionality of prosthesis and to minimize efforts and forces applied by the amputee.

The assessment of several types of outer energy sources used in children´s prosthesis has brought us to the conclusion thet the electric drive as prosthesis acting memeber is undoubted advisable. The experience of adult´s prosthetics collected in the last years both in the USSR and in other countires confirmes this standpoint. However, when choosing the outer energy source we have been influenced not only by general considerations but also we have taken into account specific requirements made for a children´s prosthesis: e.g. prosthesis control must be reliable (since the often going out of the action of the artificial "hand" traumatizes the child and can be the reason for not willing to use it); prosthesis mass and dimensions must be strictly in keeping with the structure of the child´s organism in the given space of the time corresponding to the certain child´s age only; of greate importance are further cosmetic features of the prosthesis.

The method chosen for the prosthesis control must be strictly individual according to the peculiarities of each child. It is determined by different factors: by the level of limb´s damage, its anatomo-functional characteristics, the age of the child and by the level of the mental and intellectual development.

As one of the basic criteria while choosing the method of prostheses control serves anatomo-functional peculiarities of the damaged limb, which are determined by aetiological factors. Primary task is thereby to determine the possibility of using control forces needed for the realization of a certain method of prostheses control. At present either the myoelectrical, myotonic, biomechanical control types or their combination are most wide used types of external control. The myotonic and biomechanical methods lack a number of advantages of the myoelectrical method; however, their use is justified when providing prostheses for children either after the amputation of the shoulder at the upper third or after its exarticulation.

Today the myoelectrical method of prostheses control is considered to be the most perspective one. In the majority of cases this method possesses considerable advantages in comparison with the methods enlisted. These advantages consist mainly in the possibility of essential increase of the prostheses functionality combined with minimized efforts and foreces applied by the amputee; the control of such prostheses is close to that of the natural extremity. The advantages of myoelectrical control are mostly evident either after surgery of for the patients having developmental anomaly of the upper extremity like forearm and shoulder stumps as well as for patients having developmental anomaly of the upper extremity like forearm and shoulder stumps as well as for patients with hypoplasia of their limb´s segments, In such cases the electrical activity can be abducted with necessary parameters from the "stump" muscle surface (the maximum level of the activity, separated contraction of antagonist muscles, dynamic range of the activity modifications); thus, the prostheses control is carried out in the most physiologic manner and doesnt evoke physical and intellectual difficulties in the child.

An other qualitatively new method of prostheses control, the so-called sensory one, can be suggested in the case of developmental anomaly (anatomic defect of the proxiamal part of the upper extremity associated with evident drop of the muscle function and in the presence of hand rudiments). It makes possible to reduce considerably the energy expenditures of the child when controlling the prostheses as well as to heighten its functionality. The control of the function of the prostheses acting member is realized by a hand rudiment touch the surface of the special contact plates placed inside the receiving socket of the prostheses (the force characteristics and the amplitude of dusplacement of the hand rudiment are usually reduced).

The sencory control method can find a sufficienttly wide application when providing children with shoulder prosthesis. Clinical observations have shown that the quota of children with mentioned extremity defects is highly considerable.

The system of prostheses control (the relay-and the proportional ones) is chosen in accordance with the selected control method. Its choice is realized (similar to that of the prostheses control) on the strictly individual basis depending on several factors: on parameters of the electrical activity of the muscles operating, on the level of the lesion and on anatomo-functional peculiarities of the limb, on number of contractionable muscles, on presence of hand rudiments and their mobility grade etc. In separate cases there can be used a combined controled method, e.g. the sensory-myoelectrical one.

The construction of the most perfect prostheses doesn t still quarantee that the child will master and use it active in every day life. Difficulties appear when training the children to use the prostheses what is mainly connected with the absence of phantom limb sensations (stump hallucination) in the cases of developmental anomaly and their lowering because of an amputational defect, durther with the reduce of the mobility and small force parameters of the hand rudiments. Therefore, when training the children to use the prosthesis the effectivness of the means of training in voluntary muscle contraction or in rudiment mobility, which promote to acquire stereotype skill of prostheses control, are of great importance.

At present time works at a forearm prostheses with myoelectrical control for children of 4-12 yrs. have been competed in the Central Research Institute for Prosthetics and Prosthesis Building, Moscow. For this purpose investigations have been carried out to determine the parameters of the electrical activity of forearm muscles of children with various etiology of the limb damage: principal characteristics of myoelectrical signal picked up from the surface of said muscles, a system for prostheses control, a construction of separate functional units as well as that of prostheses as a whole have been developed with regard to specificity of children's prosthetics. The prostheses was tested in a group of children of various ages having different defects of their forearms. Experimental providing have yielded positive results. The special technique elaborated for training the children to control the myoelectrical prostheses is based on the use of the indoor games elements while trainig; it makes it possible to train the child in a simple, entertainig manner. The effectiveness of this technique has been confirmed while training a considerable number of children in using the prostheses.

At present the work is carried out in two main directions: the possibility of constructing a shoulder prostheses is determined for children with amputation defects and developmental anomaly as well as for children with rudiment of hand process. In the first case the possibility to use the myoelectrical control is examined, in the second one-that of either the myoelectrical and sensory controls or its combinations. We are now at clinical observations and tests of mentioned control methods in the patients with diverse upper limb defects.

The developed prostheses models make it possible to draw the conclusion about the undoubted perspectivity of the work direction shosen. It should be noted that the preparation technique used formerly for the forearm prostheses can be successfully used also for the new task, with the exeption of some inimportant modifications, according to the anatomo-functional peculiarities of the affected extremities.