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Structured training of children fitted with myoelectric prostheses

L. M. HERMANSSON

The Arm Prosthetic Clinic, Örebro Medical Center, Örebro, Sweden.

Abstract

This paper presents an occupational therapy method for training children fitted with myoelectric prostheses. It is based upon a structured way of describing the accomplishments of a child fitted with a myoelectric prosthesis, called the Skill Index Ranking Scale (SIRS).

By using the SIRS when designing the training session, the therapist can progressively increase the demands presented to the child. Furthermore, the SIRS facilitates for the therapist the documentation and communication of the childs ability with the myoelectric prosthesis.

Introduction

Occupational therapy for children with myoelectric prostheses started developing after the successful fitting of a preschool child in 1971, (Sörbye, 1977). According to Sörbye *et al.*, (1978) myoelectric prostheses for children above three years of age have been available since 1976.

The facility founded by Dr. Rolf Sörbye in the Örebro Medical Center (ÖMC) is Sweden's major centre for childrens upper-limb prosthetics. Some 75% of 110 children supplied with myoelectric prostheses according to the Sörbye concept (Sörbye, 1977) are using their prostheses all day (6 hours or more, 4–7 days/ week). Out of the 110 children, 11% are using the prostheses half the day (2–5 hours 4–7 days/ week), and 6% are using it for a certain task at least once a week. The rest are using it sporadically (6%) or never (2%). About 10–15 new children are referred to the clinic each year.

All correspondence to be addressed to Liselotte Hermansson OT, Dept of Clinical Neurophysiology, Örebro Medical Center, S–701 85 Örebro, Sweden.

As patients are referred to ÖMC from all of Sweden, the more frequent prosthetic training is transferred to local teams. A local occupational therapist (OT), selected for the once-a-week training with the child is initially contacted by the OT at the clinic at ÖMC. The local therapist is invited to a 2-day visit in Örebro to learn about the prosthesis and the training programme. Since 1989, ÖMC has run courses for further education of OTs involved in the training of children with upper-limb prostheses.

Occupational therapy aims that the child should achieve age-appropriate independence and be able to choose to perform whatever activities he wants. The child should be as bi-manual as possible in performing the activities of daily living (ADL), the prosthesis being used as a normal, non-dominant hand. The training attempts to help the child to: 1) wear the prostheses, and 2) use the myoelectric hand.

The procedure of prosthetic fitting and training has been described earlier by Richardson and Lund (1959), Shaperman (1960[1,2]), Clarke and Patton (1980), Agnew and Shannon (1981), Marquardt (1981), Challenor *et al.*, (1982), and Garza (1986). In this paper a structured method to describe the accomplishments of a child fitted with a myoelectric prosthesis is presented. The method may be a tool for therapists in organizing training and to document and communicate a child's ability.

The Skill Index Ranking Scale (SIRS)

To provide a description of children's ability with myoelectric prostheses, a SIRS has been developed at the Arm Prosthetic Clinic at ÖMC (Table 1). According to this scale, the child's accomplishments with the prosthesis may be described on a 14 step scale. Every step on this

scale puts a higher demand on the child, compared to the previous step. By attending to the 14 step scale during training sessions the child is always presented with a new challenge. The steps represent different levels of function when using an electrical hand-prosthesis.

The SIRS is based upon:

- Sollerman's (1980) classification of grip types;
- the clinical occupational analysis as described by Hobbs-Cubie (1985);
- 20 years of clinical experience of developing skills among children with myoelectrical hand prostheses.

Principles for training

To be successful in training, the parent's support is vital. They are the ones who have to meet the day to day demands and support the child through trials and errors. The OT co-operates closely with the parents, and shares methods with them. The Swedish Dysmaelic Society, founded in 1979 on the initiative of Dr. Sörbye, supports the parents on social, financial and medical issues. Children with both/either upper and lower limbs affected, either through congenital malformation or other causes are, together with the entire family, members of the society. There are two meetings held each year, with a large number of attendees. Representatives from ÖMC regularly attend those meetings for consultation and to see the patients fitted in Örebro.

Table 1. The Skill Index Ranking Scale

1. Wear the prosthesis.
2. Use the prosthesis as support.
3. Spontaneously move and preposition the amputated prosthetic side.
4. Spontaneously place the terminal device (TD) in position and use it for support.
5. Control the grasp – release function of the TD.
6. Use a transverse volar grip, with the weight of the prosthetic limb unloaded from the child.
7. Use the tripod pinch, still without the weight of the prosthetic limb.
8. Use the transverse volar grip, without support for the prosthetic limb.
9. Use the tripod pinch with no support for the weight of the prosthesis.
10. Control the grip in various positions around the body.
11. Manipulate objects by changing their position in the TD.
12. Adjust the grip force in the TD, i.e. to hold without damage.
13. Control the grip with the arm moving, i.e. throw things with the arm hanging down.
14. Control the grip while moving the arm, throw things from above the shoulder.

Before the training commences, the OT observes the child to determine the current SIRS level. Thereafter the OT may choose an activity (according to the occupational analysis as described by Hobbs-Cubie (1985)) that increases the demands and permits the child to improve its ability. The activities chosen shall be age-appropriate. Training may be carried out on more than one SIRS level at a time. For example, a child at level two may perform grip-training while, at the same time, spontaneity is aimed at. The training must always be fun and encourage prosthetic use. The training in Örebro is mostly performed in individual sessions, when the OT is alone with the child. The relationship between the OT and the child is very important. Parents may be present until the child feels safe and secure with the therapist. Group sessions may be arranged depending on the number of children in a particular area. In a group of children with similar prostheses, problems and abilities, the children get support and help to further develop their abilities. After the training sessions the parents are told the current status and achievement. Videotape recordings are used to show the child's ability, and they sometimes get "homework" to practise until the next training session.

A very important factor for successful prosthetic fitting, is the follow-up in Örebro. Every six months if the family has not been in contact with the clinic, the OT calls them to check how the child is doing, and if everything is working as planned. An adequate prosthetic maintenance service is provided as well as spare prostheses for the child.

To wear the prostheses (level 1–4)

In order to stimulate pre-school children in prosthetic use, the therapist first may have to divert the interest of the child from the prosthesis, and its weight, using interesting objects and/or games. Thereafter the child may be made aware of the usefulness of the artificial limb, through some activity, and finally get credit for using it. For the older child, wearing should first be connected to certain activities and/or situations. When the habit of wearing the prosthesis is established, a wearing-habit that, finally covers most of the day is aimed at.

If the prosthesis seems to obstruct the movements of the child, the OT must guide the

child into a better movement pattern. As the prosthesis must be regarded as an extension of the residual limb, it should not impede but improve the limb's function. It should be involved in the childs body-image and, for example, swing naturally when walking, and be placed spontaneously on the table when sitting.

Training through bilateral gross motor activities for the arm, combined with wearing-training may, in time, make it easier for the child to obtain spontaneity and supportive use of the prosthesis.

The first four steps in the SIRS may be used for documentation of skills with a passive Terminal Device (TD), and as criteria for when to change to an active TD as well as for training with a myoelectric prosthesis.

To use the myoelectric hand (level 5–14)

For children, with previous experience of a passive TD, movements in the myoelectric TD appear spontaneously and involuntarily. Through visual feedback the child learns to control opening/closing in a reasonably short time (between one day and a fortnight). Difficulties in controlling the myoelectric hand sometimes, in the experience at Örebro, occur among children fitted when older than five years of age. It seems to be the same problem as adults have when first fitted with a myoelectric hand. To find the right muscles for contraction, biofeedback visualized on a screen where muscle activity may be separated, is sometimes used. Biofeedback is used in the same way when there are problems with co-contraction (i.e. when antagonists are activated simultaneously with the agonist).

The child may find the myoelectric prosthesis, heavy when first fitted and this may interfere with the ability to control the grip. The SIRS suggests, therefore, that the training commences with activities where the weight of the prosthetic limb is unloaded from the child. For example sitting with the prosthetic arm on the table, holding an object in the TD and working upon it with the other hand. As the child's ability increases, the difficulty of the task increases. Throwing things from above the shoulder is the most difficult thing to do.

As its prehensile skill increases, the child will be able to use the artificial grip more effectively. When manipulatory skill is achieved, the child will learn to adjust the grip force to the object, i.e. to hold hard enough without damaging the object. Sollerman (1980) describes eight different grip types. The most commonly used electrical prosthesis offers two grip types, the transverse volar grip and the tripod pinch. It may, however, be possible to use the myo-hand for the other grip types as well, although not quite so well.

Clinical experience of children with myoelectric prostheses has shown that some of them have been able to learn to control the grip, before actually having achieved spontaneity and supportive use. They do not, however, use their prostheses in daily life and the usefulness of the prostheses is therefore small. Ability at all levels of the SIRS is needed if optimal use of this sophisticated tool is to be obtained.

Intensive training camps

Since 1978, intensive training has been used to treat children fitted with hand prostheses. Each year during the summer holiday, about one week before school begins, children, 6–9 years of age, accompanied by one of the their parents, gather to attend the training camp.

Twice during the week the physician and prosthetist visit the camp for examinations and prosthetic maintenance.

The aims of the training camp are that the child will be able to use the prosthesis spontaneously in daily life, and that the parent will be able to support the child in its development.

The intensive training camp attempts to:
- support the child in developing a positive self-image;
- motivate the child to prosthetic use;
- support the child in developing bimanual skills;
- support, teach and guide parents.

The intensive training camp features:
- a structured programme based on play-activities;
- demanding, fine motor activities in the morning;
- social and gross motor activities in the afternoon;
- age and ability related groups;
- parental participation in training;
- parental discussions;
- closing festivities.

To know the child's prosthetic use and ability, the OT initially interviews and assesses the child (according to the SIRS), and forms an individual programme. The assessment is repeated at the end of the week to evaluate the result.

The results from a training camp show that the attendees get increased prosthetic use as well as use of the artificial grip. Furthermore, the children get better self-confidence.

Training with multifunctional and bilateral prostheses

Multifunctional electrical prostheses have been supplied to a few cases at ÖMC. These prostheses normally feature a powered TD and a powered elbow or wrist unit. In order to evaluate the possibilities for a patient to operate a multifunctional prosthesis, a computer based control system has been developed (Philipson, 1985; Philipson and Sörbye, 1987).

By means of this device it is possible to design a circuit that controls one to eight different output states from two myoelectric electrodes. The benefits of this system are that all parameters of the control (i.e. sensitivity, switch levels, degree of acceptable co-activation etc.) may be easily adjusted in the software. With the device, it is also possible to find out whether or not the patient is a possible candidate for multiple-state control.

The computer based myoelectric control system has proven to be a useful tool for training and evaluation of patients. It also saves time since a complicated prosthesis does not have to be built until the patient has shown the capacity to operate it.

In cases of bilateral deficiencies the children at ÖMC usually get a powered prosthesis on one side and, in the case of a high level deficiency, a passive or body powered prosthesis on the other side. The training follows the SIRS, with sufficient adaptations with respect to the limitations imposed by the deficiency.

Financial implications for myoelectric prosthetic fitting

In Sweden, medical care is provided by the tax financed social security system. This gives the parents different kinds of economic support (Fig. 1).

A patient pays a small fee to see a doctor in Sweden. If the orthopaedic consultant considers that the child would benefit from a prosthesis, all the equipment is free of charge. That includes one, or more, prostheses, at least three batteries and a battery-charger. Furthermore, new gloves, change of socket and repair is free. Training and follow-up are, financially, regarded in the same way as the medical consultation, i.e. associated with a small cost.

Child care allowance

If you have a handicapped or a sick child who needs special supervision and care for at least six months, you can obtain a child care allowance. Additional costs that you incur are also relevant when the insurance office decides whether you are entitled to a child care allowance. The child must be under the age of 16 years. It the child is cared for in an institution you can obtain a child care allowance for the days when the child is at home. If the child needs a great deal of supervision and care, you can obtain full child care allowance. There is also a half child care allowance (and as from 1 July 1988 also a quarter allowance). If there are several handicapped children in the same family the insurance office will consider the total need for supervision and care and the additional costs. This means that a child care allowance may be obtainable even though none of the children would qualify individually for such an allowance.

Part of the child care allowance may be exempt from tax.

For further information, read the brochure **Child Care Allowance and Disability Allowance.** Obtainable from the social insurance office!

From "Useful information on Social Security"
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Fig. 1. Part of the financial implications for children with limb deficiencies in Sweden.

Conclusion

The training of children with myoelectric prostheses according to the SIRS has shown to be an efficient way to achieve a high level of independence. In Örebro, the SIRS is an integrated part of the entire fitting and training procedure. The scale has proved to be a useful way of describing the current skill level of an amputee. It is used to organize the training sessions effectively and also for assessment of the child prior to a change from a passive to a myoelectric terminal device. Furthermore, the SIRS can be used as an evaluation tool when studying which training technique is the most efficient.

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