Prosthetics and Orthotics International, 1998, 22, 150–154

Powered prosthetic hands in very young children

D. DATTA and V. IBBOTSON

Mobility and Specialised Rehabilitation Centre, Northern General Hospital, Sheffield, England

Abstract

Myoelectric prostheses are generally not provided in the United Kingdom for children before the age of 3½ years. Following the introduction of a smaller sized electric hand in the United Kingdom in 1993 the authors decided to introduce electrically powered hands for a group of congenital upper limb deficient children at a much younger age compared to normal practice.

Eleven children were introduced to powered prosthetic hands at an average age of 20.6 months. At the review carried out for the purpose of this paper, 72.7% of these children appeared to be successfully using these powered prostheses. Fitting these young children with powered prostheses and encouraging acceptance and operation of the prostheses appeared to be much less of a problem than might have been anticipated. The parents of all these children have very much liked the introduction of powered hands at this early age and have contributed positively to the prosthetic programme.

The authors' experience suggests that introduction of a powered prosthesis at a much earlier age can be a more suitable alternative than provision of a body-powered prosthetic device while waiting to reach an older age before a powered prosthesis is considered.

Introduction

In the management of upper limb deficient children, early prosthetic fitting is now generally accepted to be beneficial. Children are usually advised to be fitted with a cosmetic passive device as early as between 3 months to one year (Datta and Brain, 1992; Patton, 1989). Progression from a passive cosmetic prosthesis to an externally powered prosthetic device has generally been determined by the enthusiasm and expertise of the individual centre, availability of resources for payment for the prosthetic limbs, availability of suitable and appropriate prosthetic hardware, as well as other selection criteria used by the rehabilitation team. Historically in the United Kingdom (UK) children generally progress to receiving their first myoelectrically controlled prosthesis between the ages of 3½ to 5 years, usually having used a body-powered device, like a split hook or mechanical hand since about 18 months of age (Datta *et al.*, 1989; Mendez, 1985). Applications of electrically powered prostheses in young children as early as between the ages of 12 to 18 months has been reported by a centre in Canada (Hubbard *et al.*, 1992).

When the SCAMP hand was launched in the UK in 1993 by Hugh Steeper UK Limited, the possibility of application of powered hands for younger children in the UK became a more available option. Therefore, with the availability of a more affordable smaller electric hand and encouraged by the initial reports from the Canadian group, the decision to prescribe these powered hands to a much younger group of children was taken in the centre in Sheffield. This report describes an experience of using powered prosthetic hands in very young children.

Patients and methods

During 1994/95, eleven children with

All correspondence to be addressed to Dr D. Datta, Consultant in Rehabilitation Medicine, Mobility and Specialised Rehabilitation Centre, Northern General Hospital, Herries Road, Sheffield S5 7AT, England. Tel: +44(0) 114 25615721 Fax: +44(0) 114 2431646.

Table 1. Profile of subjects (N=11).

Level of congenital loss	Male	Female
Right below elbow	1	2
Left below elbow	1	6
Right through elbow		1

unilateral congenital upper limb transverse deficiency were considered to be ready to progress from their passive cosmetic prostheses to more functional devices. Details of these children are presented in Table 1.

Ten out of these 11 children were being seen regularly at the authors' clinic from an average age of 4 months (range 0-8 months), the remaining child was transferred from another centre at the age of 33 months. Prior to prescription of powered prostheses, 7 were wearing passive cosmetic prostheses, and 4 were wearing body-powered grippers.

The decision to change to the SCAMP hand was for the reason of introduction of a more efficient functional device to allow improvement in age appropriate independence and to encourage bimanual activities which the body-powered or cosmetic devices were not fulfiling. These children were selected to be included in this programme for powered hands as they had already demonstrated their developmental readiness and the family showed commitment to fully participating in the programme.

Use of the Otto Bock Myo-trainer and the occupational therapists involvement are described later. The prosthetic details of the new powered devices are given in Table 2.

All sockets had a pull hole so that the use of a silky pull-through 'stump sock' could be used to enable easier application. All had a single electrode sited over the lateral aspect overlying the common finger and wrist extensor muscle group for below elbow deficiency to allow voluntary hand opening. For the child with through elbow level of deficiency, the single electrode was placed overlying the triceps muscle. No on/off switches were fitted. In all cases Liberty-Mutual half size 6 volt batteries were incorporated in the prostheses (Figs. 1 and 2).

Fig. 1. SCAMP myoelectric hand in use by a child with below elbow deficiency.

A brief questionnaire was devised to gauge parental opinion and sent to the parents at the time of review.

Results

Myoelectrically controlled SCAMP hands were introduced to these children at an average

Table 2. Details of powered prostheses.

Self suspending socket	10
Additional strap (above elbow cuff)	5
Through elbow socket with hinge elbow joint (side steels)	1
2" SCAMP hand	5
1½" SCAMP hand	6
Otto Bock electrode	2
Steeper electrode	9
Liberty-Mutual Batteries	11

Fig. 2. SCAMP myoelectric hand in use by a child with through elbow deficiency.

of 20.6 months (range 15 months to 34 months). The use and utilisation of the prosthesis for these children were reviewed at an average of 25 months (18-34 months).

At this review, 7 children were continuing to use their powered prostheses only, while the remaining 4 also continued to use their cosmetic prostheses for some parts of the day while they were not wearing their powered prostheses.

Eight out of 11 (72.72%) were successfully wearing powered prostheses for an average of 6 hours per day (range 4-9 hours) on an average of 6.3 days per week (range 5-7). One child has currently abandoned wearing the prosthesis after 15 months of good use and 2 others are showing great reluctance – which may be related to persistent fitting and other electro-mechanical problems with their prosthesis.

All 11 children learned to open the SCAMP hand relatively quickly, though some in more controlled fashion than others.

All 11 questionnaires were returned by the parents which revealed that all the parents felt that the powered prosthesis had been provided at the right time. Nine children accepted the new prostheses readily when the programme was started and all could be encouraged to operate and use the powered hand in the house during play and some daily living activities appropriate to their age group. Eight families felt that electro-mechanically the prostheses were very reliable and 3 were less enthusiastic. There was general consensus that battery life span was too short and some children needed up to 3 batteries per day. The heaviness of the prosthesis was commented on by 3 parents causing a problem with the arm dangling when the child was tired. One parent commented on the bulkiness of the hand and prosthesis as a whole in respect of clothing.

Discussion

A number of reports have supported the effectiveness of providing myoelectric prostheses as rehabilitation aids for upper limb deficient subjects.

Improved cosmesis, elimination or reduction of harness, improved grip force controlled by more natural body movements, decreased effort, ability to work close to the body and at various planes for electrically powered prostheses have been well documented (Datta and Brain, 1992). These advantages generally out-weigh the disadvantages of increased weight, lack of durability in play activities with sand and water and the possibility of more frequent maintenance according to the parents of the children, which is similar to the authors' observation.

In their past experience, body-powered prosthetic devices used between the ages of 18 months to 3½ years which is the common practice in the UK, have been rather restrictive and many children tended to use them as passive devices. Split hooks, which probably can be the most functionally effective terminal device are generally not favoured by parents because of social and cosmetic reasons and for fear of injury to the children themselves or to others. The CAPP device has not found favour by children and parents in this centre. Poor grip force offered by mechanical body-powered hand or gripper devices, discomfort and restriction created by wearing a harness and unnatural body movements to perform bimanual tasks may encourage some children to become one handed when such devices are prescribed, rather than become as naturally bimanual as possible. It is important to be able to provide these children with a prosthetic device which is most efficient for their needs.

There have been 3 main concerns regarding application of electrically powered prostheses in children under 3-3½ years of age, i.e., the availability of very small sized electric hands, uncertainty of correct location of electrodes in the socket and training strategy in the use of myoelectric prostheses.

Though Variety Village market a small powered hand suitable for very small children, they have not been used much in the UK because of the import costs and uncertainty of technical

back up.

The introduction of 1¾ inch and 2 inch SCAMP hands in Britain by Hugh Steeper Ltd., filled a major gap in Britain for younger children. Use of single electrodes in operating a voluntary opening hand with automatic closure was adequate for the needs of the youngsters in the trial. In a previous report of the SCAMP hand it was noted that though existing users of myoelectric hands using 2 electrodes had no difficulty in changing to a single electrode SCAMP hand, though bimanual tasks were more difficult and took longer for timed performance tests. (Kingston *et al.*, 1995).

The authors preferred to use myoelectric control rather than pull switches for use with SCAMP hands in these patients, as pull switches would have required the use of restrictive operating loop and harness and the unnatural action of pushing the hand away from the body to activate the hand operations.

The location of the single electrode over the lateral aspect of the below elbow stump was chosen because of the anatomical location of the hand extensor muscles. Formal location of electrode site to obtain best electro-myographic signals are not possible in such young children. A little trial and error at fitting stage and adjustment of the sensitivity of the electrode were sufficient to obtain a reasonably optimum location of the electrodes.

In this series, 8 children were given between 1 and 4 training sessions with the Myo-trainer (Otto Bock) using a toy train set which moved and stopped by using EMG signals generated from the stump. The impression was that the children who used the Myo-trainer transferred more easily to the SCAMP hand, though this cannot be proven. There was, however, no correlation between the use of the Myo-trainer and eventual usage pattern of the powered prostheses. The occupational therapist found the Myo-trainer to be excellent diversionary equipment to engage children to identify potential candidates and also an informal training aid for use of powered prosthetic hands.

In this group of 11 children, 72.7% appeared to be successful in using their myoelectric prostheses in terms of the extent of wearing their prostheses as well as subjective observation of using their prostheses actively and passively in their play and other daily activities. This is similar to 69% success in the use of myoelectric prostheses for a group of 29 children under 16 years of age of congenital below elbow transverse limb deficiency who went through the usual, but conventional practice of not receiving the myoelectric prosthesis before the age of 3½ years, (Datta *et al.*, 1989). A longitudinal follow up and a larger study will be required to form any definitive conclusion whether early provision of powered prostheses can make a significant difference to the rehabilitation programme, compared to a later provision.

There is no doubt that parental involvement and commitment has a positive effect on the child conforming and co-operating with an early powered prosthetic programme. Monitoring will be needed on these children to see how they develop in future.

There has been no significant increase in the amount of time required to assess and fit the powered prostheses and no increase in the number of appointments to the clinic have been necessary. In the authors' clinic it is usual practice to see children at 3 monthly intervals unless a significant change necessitates an earlier intervention. The occupational therapist's involvement with these children outside the multi-disciplinary clinic also has not shown any significant increase in the time element.

Early referral to develop good relationship with the multi-disciplinary team of a specialised centre, regular reviews, input of specialist occupational therapist at the centre, at home and school/nursery, peer support from other children and parents, specialist technical and "drop in" prompt and efficient repair facilities are necessary. Suitable surroundings conducive to training with age appropriate toys have all positively contributed to the management of these children.

No child in this project was refused the opportunity to progress to the powered hand, but when the authors were not convinced that the timing was right, their concerns were discussed with the parents and provision deferred until circumstances were more favourable. Of course there are children attending the centre where an electrically powered prosthesis has not been provided, but this is outside the subject of this paper.

It appears to be an attractive option to switch to electrically powered prosthetic hands for much younger children than previously practised in the UK. The rejection rate is not higher than

other previously reported use of myoelectric prostheses in children with below elbow deficiency. The electrically powered prostheses are very much liked by parents and therefore parental participation has been positive. Most children in the group learned to operate the hand reasonably quickly and demonstrated the beginning of control in a relatively short space of time.

The key to success of a prosthetic and rehabilitation programme is to be able to provide the appropriate prosthesis for these children, at the appropriate time together with appropriate and continuing support from a specialist centre. Regular monitoring and review is necessary as the children continue to grow and their needs change.

The additional expenditure of providing electrically powered compared to body-powered prosthesis in this age group did not cause financial difficulties in the centre which is funded by the National Health Service. The additional cost was the difference between a body-powered prosthesis and the powered prosthesis. As the number of children with congenital limb deficiency attending any one centre is likely to be small, it is not thought that the additional expenditure in earlier provision of electrically powered prostheses, when indicated, is likely to be significant. It certainly appears to have increased parental contribution as "co-therapists" and may have decreased rejection or very poor use of inefficient body-powered prosthetic devices. The actual fitting process of electrically powered prostheses in such young children and their tolerance to wear this prosthesis and the ability to gain some control of the hand has not proved to be as problematic as one might have expected.

REFERENCES

DATTA D, BRAIN ND (1992). Clinical applications of myo electrically-controlled prostheses. *Crit Rev Phys Rehabil Med* **4**, 215-239.

DATTA D, KINGSTON J, RONALD J (1989). Myo-electric prostheses for below-elbow amputees: the Trent experience. *Int Disabil Stud* **11**, 167-170.

HUBBARD S, BUSH G, KURTZ I (1992). A developmental approach to myo-electric fitting and training. In: Proceedings of 7th World Congress of the International Society for Prosthetics and Orthotics, Chicago, Illinois. p355.

KINGSTON J, RONALD J, COOPER R, DYKES W, DATTA D (1995). The clinical trial of the SCAMP 2 inch hand. In: Proceedings of the Annual Scientific Meeting, International Society of Prosthetics and Orthotics, Hull, England. p49.

MENDEZ MA (1985). Evaluation of a myoelectric hand prosthesis for children with a below-elbow absence. *Prosthet Orthot Int* **9**, 137-140.

PATTON JG (1989). Developmental approach to paediatric prosthetic evaluation and training. In: Comprehensive management of upper limb amputee./edited by Atkins DH, Meier RH. – New York: Springer-Verlag. p137-149.