Temporary Upper Limb AIIMS Prostheses - A New Design

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Abstract

Amputation of upper limb causes immediate disturbance in the body image during postoperative period. Early fitting of the prosthesis helps to incorporate the prosthesis in the body image, reduction of stump edema, stump pain, promotion of two-handed activities, prevention of muscle wasting, scoliosis and more acceptance of permanent prosthesis. First four to six weeks of post-operative period are considered to be the golden period to achieve better success in upper limb amputee rehabilitation. Not much has been done in the field of upper limb temporary prosthesis in the last twenty five years. To address this gap a new temporary upper limb prosthesis was designed and fitted to six patients. The design is simple, low cost and functional. It can be fitted immediately after surgery. It is also helpful in cases with open wounds and stump neuromas.

Introduction

The loss of upper limb represents an extreme disability particularly because the sophisticated manipulative functions of hands are lost. There is a lot of divergence of prosthetic functions compared to the upper limb functions. Majority of the patients with upper limb amputations belong to a younger age group. Commonly, amputation is a result of trauma and thus patients do not go through any pre operative stage to prepare them better for the prosthesis fitted later. The limb loss is visually more apparent which attracts attention of others. This altered body causes a series of psychological reactions including anxiety, depression, poor self-esteem and reduced life satisfaction.

Amputation requires a revision of body image. It is hypothesized that there is a relationship between the perception of body image and their psychological well-being of the amputees. Successful adjustment for the amputee appears to be in the incorporation of the prosthesis into his body image as soon as possible. It has been shown that early fitting results in better incorporation of prosthesis into the patient's body image, better adjustment to the amputation and more acceptance of the prosthesis. Success rate for adult upper limb amputee rehabilitation varies from 7-50%[1-7].

Berlemont reported the first immediate fit prosthesis for lower limb amputation in 1958 [8]. In 1965, Burgess et al [9] achieved accelerated rehabilitation, increased acceptance of the prosthesis and less psychological trauma when immediate fitting was performed in lower extremity amputation. The other advantages of the use of immediate post operative prosthesis (IPOP) and early prostheses include promotion of wound healing, decrease in stump pain through control of post operative edema, reduction in phantom pain, prevention of atrophy of muscles and scoliosis because of imbalance, earlier fitting of definitive prosthesis and improvement in patient's general condition by preventing mental depression secondary to limb loss[1,10,11].

The concept of immediate fitting of prosthesis is not widely used in case of upper limb amputations. Only a few studies have been done in this field and a few options are available for immediate postoperative fitting of prosthesis and that too with limited experience[1, 4, 10-12]. We did not come across any studies done on this aspect over the last twenty five years. To address this gap we have designed a low cost temporary prosthesis that is simple, functional and can be made from locally available materials in a short time period.

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Material and Methods

A total of 6 upper limb amputees who attended Department of Physical Medicine & Rehabilitation, All India Institute of Medical Sciences (AIIMS), New Delhi between 2004-2005 were included in this study. There were four male and two female patients in the age group of 20-42 years; the average age was 29.3 years. One female patient was in the post-partum period and at that time was required to be breast-feeding. Level of amputation included one through wrist amputation, three above elbow (all short stumps) and two below elbow amputations. The etiologies for amputation were trauma in two patients, following tumour ablation in three patients and surgery for peripheral vascular insufficiency in one patient. All these patients underwent surgery in the departments of General Surgery and Orthopedics at AIIMS. The patients were referred to the department of PMR for rehabilitation. The prosthesis was fitted to the amputees between five to 15 days (average 9 days) after surgery. Training for use of the prostheses in activities of daily living was given by the occupational therapists for four hours a day for six days after fitting of the prosthesis.

Concept and Design of Prostheses

Suspension: Consisted of figure-of-eight harness.

Socket: In the above elbow amputation cases the socket was made of laminated polyresin with open distal end. In two cases the socket was made of polypropylene, it was kept open distally and medially.The difference in the circumference at various levels was accommodated by the use of velcro straps (Fig 1).

Arm and Forearm pieces: Metal uprights on the medial and lateral aspect were used for arm and the forearm pieces. These were connected to together with metal bands and were covered with leather. The terminal device was attached distally with one U shaped band of mild steel (Fig 2).

Elbow joint: A pre-fabricated drop ring knee joint manufactured by Artificial Limb Manufacturing Corporation of India (ALIMCO) was used for elbow joint. The ring lock was dispensed with. Only flexion - extension was allowed. Hyperextension was restricted with the help of stopper.

Control cable: It extended from the harness to the terminal device and was guided along the metal uprights.

Wrist joint: Wrist joint was used only in one case. It was made of rounded plates of polypropylene proximally secured to the forearm piece at the U shaped bar. These plates acted like constant friction joint and could be rotated to the desired degree.

Terminal device: Voluntary opening hand covered with cosmetic glove was used.

Cosmesis: Proximally and distally hollow spaces were covered with ethalex cylinder. The distal forearm piece was covered with nylon stockinet for better cosmesis (Fig 3).

Weight: The prosthesis weighed about 400 grams.

Results

After training the patients with activities of daily living (ADL), the patients could perform the bilateral hand activities like the use of the prosthesis in assisting the normal hand in holding newspaper, kitchen work, opening and closing door, folding of bed clothes etc. The patients were using this prosthesis for about 5-8 hours a day for 8 weeks till the permanent prosthesis was delivered. The open wounds healed well while the patients were using the prostheses. There were no complications related directly to the use of prosthesis. The female amputee in post partum period used to breast feed the neonate with the support of the prostheses. All the patients were happy with their body image and the prosthesis was cosmetically well accepted.

Discussion

Many patients having the upper limb amputation prefer not to wear a prosthesis. Multiple factors influence the acceptance of the prosthesis and its use. One major reason for this is that the patient quickly learns to compensate the loss by the use of the contralateral normal upper limb. It often occurs to such a degree that the apparently cumbersome prostheses is not accepted and frequently abandoned. A study done by Vitali et al[13] reported a 67% rejection rate for standard below elbow prostheses. Recent study done by Biddiss et al[14] showed a mean rejection rate of 45% and 35% in the literature for body-powered and electric prostheses respectively in pediatric populations. The scenario in India is entirely different with not many fitting centers for prostheses and poor knowledge of the doctors and patients about the availability of prostheses leading to poor prescription ad rejection due to late fittings.[15] In adults rejection for body-powered prosthesis was 26% and the electric one was 23%[14]. The average incidence of non-wear was similar for pediatric (16%) and adult (20%) population[14]. To prevent this rejection and to promote the wearing of prostheses, early use of upper limb prosthesis is helpful. With early fitting, learning bilateral hand activities immediately after surgery can be instituted few days after amputation so that single handed patterns of activities do not get established early or are prevented to be developed.

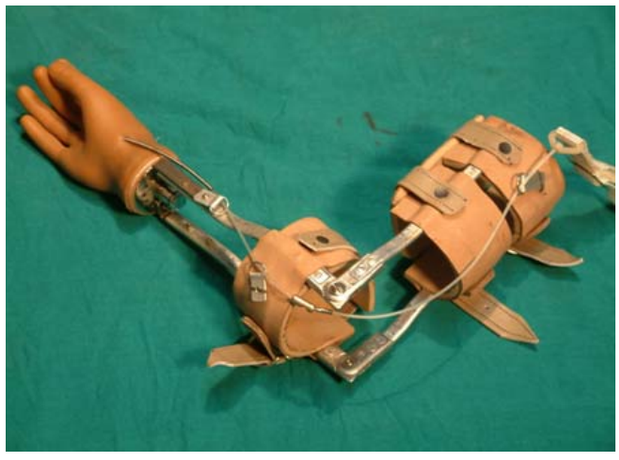

Fig 1. Basic design of the prosthesis.

Fig 2. Below elbow amputee having open wound fitted with prosthesis.

Fig 3a. Above elbow amputee in the early post-operative period having sutures in place.

Fig 3b. Above elbow amputee fitted with the prosthesis without cover (top) and with cosmetic cover (bottom)

The present prosthesis can be fitted despite the presence of open wounds and it is not a deterrent to the temporary prosthetic fitting and early prosthetic training.

Robinson KP et al[10] reported three patients, two with above elbow and one with through wrist amputation that were fitted with immediate prosthesis on the operating table with plaster of Paris cast attached to a hook. In all the patients function was rapidly established. The patients did not become single-handed and they continued their prosthesis throughout their working hours. In another study reported by Burkhalter et al[1], the results of immediate and early postoperative prosthetic fitting in 96 upper limb amputees were reviewed. Initially 11 patients with below elbow amputation plaster of Paris cast was applied to the arm with a hook attached to it within 4-5 days of surgery. Later on, they put the cast in two parts, one above and another below the elbow connected by a polycentric hinge joint. This design caused swelling at elbow joint because of constriction. So they used silastic insert between stump and socket for wound protection.

Because of volume fluctuation frequent changes of insert were required. No local wound complications were noted. Twelve out of 96 patients rejected the prosthesis.

Rate of prosthetic acceptance was high in cases of early fitting. The deficits in these designs were that there were chances of pressure necrosis with plaster of Paris cast and total contact socket, along with increased chances of infection. Plaster of Paris cast with fixed hook can cause discomfort to the patients during sleep and other activities of daily living. In the above studies, the prostheses were not fitted with wrist joint or hand as terminal device. The above shortcomings have been addressed in our design. The main advantages of our prosthesis are as follows:

1. Simple design, low cost prosthesis with adequate suspension

2. Adjustable distal open socket is useful in stump neuromas, open wounds and in patients with sensory deficit. The prosthesis can be used with sutures or dressing in situ.

3. Easy to make and requires very little time for fabrication.

4. Use of different terminal devices is possible

5. It was cosmetically acceptable to the few patients fitted.

6. The prosthesis or parts of the prosthesis can be reused; sliding bars can be used for limb length adjustment

7. This design can be used as a prefabricated prostheses for training.

8. Light weight with total weight about 400 gm.

9. The total cost for the parts of the prosthesis is less than Rs 1000.

Conclusion

The new design of the prosthesis is feasible for use without the complications of fluctuating girth of the healing stump after surgery as well as for stumps with open wounds. It is easy to make with locally available materials. With our limited experience of fitting, it appears to be accepted well and has a scope of wider use in improving the rehabilitation outcome in upper limb amputees.

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