IJPMR 6 (2) Oct. 1993
Guest Article

Rehabilitation of Arm Amputees

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Man's attempt to find a suitable artificial substitute for the loss of an extremity begins with the earliest history of mankind. Ancient history affords examples of prosthesis used at the begining of the fifth century BC when a native of ELIS and a Seer was thrown into prison and condemned to death by the Spartans. He escaped by amputating his leg and then fitted himself with a wooden foot. He was again present at the battle of PLATACA in 479 B.C., until caught again and put to death. Probably, the most historic of all antique prostheses was an artificial hand by Goetz Von Berlichingen in 1509, who had lost a hand in the seige of Landshut in Bavaria. It was an amazing example of the skilled craftmanship of that period.

Some of the artificial limbs and other appliances of by gone ages in some of the museums of europe, speak of the excellent workmanship. Whereaas, the artificial leg or support, enabled them to walk again, the artificail arms and hands were so designed that by wearing those, it would be possible for soldier to hold bridle of the horse, leaving his second arm free to wield a sword.

However, real changes were seen in this field only in the first half of the present century - especially after the two world Wars (1914-18 and 1939-45). The present day artificail limbs, their remarkable improvement in design and mechanical efficiency coupled with marke advances in the surgical techniques are the result of experience gained from thousands of amputations during the two Great Wars, , besides the combined efforts of the orthopacdic specialist and the Limb Marker.

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Unfortunately, Indian history does not say much on the subject except for the crude type of aids

As our know-how in this field were rather of a primitive nature, the then Government of india, invited a team of experts from Roehampton-London in 1945, to advise on the rehabilitation of a fairly large number of disabled soldiers-both from World War I and World War II. It became necessary to do so from the morale point of view - specially when the disabled British troops and disabled Class I Indian Commissioned officers were being sent to England for geting their artificial limbs/aids. The experts suggested training of our personnel in England for setting up an Artificial Limbs Centre in India. On their recommendation a team of 13 craftsmen from the Corps of Electrical and Mechanical Engineers, Indian Army went for training at Roehampton. along with 3 surgeons from the Army Medical Corps. The author was asked to establish Artificial Limb Centre at Pune as Founder-Director. Over the years, a few Limb Fitting and Rehabilitation centres have been established for the disabled civilians - besides the Artificial Limb Manufacturing Corporation of India (A Govt of India enterprise) at Kanpur.

DEVELOPMENT OF ARTIFICIAL ARMS

Although, a lot has been said, written or claimed, the fact remains that rehabilitation of the arm amputees, still has not reached its desired perfection anywhere in the world-despite extensive and expensive re-search and introduction of electronic arms/hands. There appears to be complete lack of understanding to the limits to which any arm prosthesis may reasonably be expected to function. Also, there is lack of honest and realistic interpretation of these

limitations to the patient with arm amputation.

Unfortunately the functions, sense of touch and prehension cannot be duplicated in the artificial hand. Other factors for not showing interest are.

(a) Comparatively, the number of arm amputees is far less than the leg amputees.

(b) A leg amputee becomes immobile and grounded without an artificial support. He will therefore, accept anything that can give him mobility; be it a pair of crutches, a peg leg or a sophisticated prosthesis, whereas a arm amputee requires something that gives him genuine utility and confidence.

(c) The loss of an arm will not, (unless a bilateral amputee, totally disable a person to the same extent as would a loss of one leg which has a definite bearing on the functioning of the other (sound) leg. While both legs form a systematic unit, each arm must be considered, more or less, an independent individual. In a large number of cases, he would not like to wear the artificial appendage constantly or will even discard it.

(d) The disability of the upper extremity, does not hinder the tasks of locomotion and weight bearing.

(e) A human arm has vital mechanisms of supporting, pulling and pushing the body, of gripping and holding, of feeding and clearing, of protecting and fighting. Besides, the human arm and hand serve as a means of expression for many primary psychic functions.

Inspite of what has been stated above and the difficulties encountered-both by the amputee and the limb makers, practically all arm amputees can be and should be fitted with a suitable prosthesis, through proper judgement and selection of the type required. To create the desired confidence, and for getting the maximum utility, greater attention must be paid on training the amputee to use his prosthesis/appliance. Without proper training, the entire effort will be futile.

Like lower extremity, the causes for the loss of upper limb are :

(a) congenital deficiency of a limbs

(b) disease and infection, - leprosy, malignancy gangrene etc.

(c) gun shot wounds

(d) accidents - including industrial hazards and mechanised farming eg. Thrasher Victims

Unfortunately, in Punjab and its neighbouring States with agro-industry a fairly large number of labourers loose their arms (one or both) during every thrashing season. This is indeed pathetic, specially when practically all victims are from the lower income group.

An attempt was made, a couple of years ago, to study the same through the Punjab Agriculture University at Ludhiana. It was found that during the wheat thrashing season of 1980, as many as 301 cases were located. Considering the number of wheat thrashers curently used in the state of Punjab to be about 2.3 lakhs, it comes to about 13 accidents per 10,000 machines in use. The accidents take place in all age groups and include female victims as well (3 to 4 percent). Main causes for these accidents are defective designs of the thrashers i.e. absence of safety devices, lack of proper training to use the machines, greed of the landlord for enhanced production, greed of the worker to earn more, irregular electric supply and use of drugs/intoxicants by the operators to get over the fatigue because of prolonged hours of hard work in the fields.

Correct amputation and post-operative treatment simplify the manufacture to a great extent, experience has shown that the amputations carried out in some of the district hospitals are fashioned with little or no regard for their functional requirements or from the prosthetic point of view. The tendency on the insistence of the patient has been to save the maximum. But an 'Ideal Stump' allows for fitting of the proper

mechanisms, e.g. wrist and elbow etc. These briefly are :

(a) Hand

If all the fingers are stiff or do not work voluntarily, the amputation should be performed through the forearm and NOT the wrist, to enable incorporation of the wrist mechanism.

(b) Below Elbow

Ideal length is seven inches from the elbow joint. Minimum that can be fitted is four inches of ulna.

(c) Above Elbow Ideal length is eight inches, minimum that can be fitted is about five inches; measured from the acromion process.

(d) Through shoulder

Save at least one inch; since the head of the humerus affords prominence round which the shoulder cap can be moulded and fitted properly.

(e) Through Elbow

amputation is NOT desirable as it makes the prosthesis clumsy and ill fitting.

Other qualities required of an Ideal Stump, briefly are :-

(a) Scar should be terminal and NOT anterior or posterior, to avoid rubbing of the Scar against the socket and consequent damage, as upper limbs are not end weight baring. Stump, of course, should be soundly healed.

(b) Flap - The shorter the flap, the better it is for circulation and the wound will heal quicker. The flap should be linear without folds, freely mobile and away from pressure.

(c) Similarly, division of muscles, division of bones and proper treatment of nerves during operation, require careful planning - besides post-operative care.

(d) Stump should tolerate firm pressure and patient ought not to complain of tenderness when stump is firmly grasped.

(e) Joints above the amputation should move fully.

FITTING OF PROSTHESES

Arm cases can be fitted as soon as the stump is fully healed-specially if the patient complains of phantom pain. In fact, if the prosthesis is fitted earlier, it becomes much easier to train the amputee to use it.

As far as possible, the rehabilitation of an arm amputee should commence immediately after amputation. Physical rehabilitation of a patient cannot achieve complete success unless attention is given to his mental rehabilitation.

The desire for an artificial limb is frequently absent if the patient is referred late to a limb fitting centre. Some patients are proud that they are able to perform most actions with one hand. Nonetheless, they should be given encouraging talks, audio-visual aids and preferrably demonstration by those already wearing artificial arms.

On the other hand, bilateral arm amputees present quite a different picture. The shock and horror at the loss are much greater. Their plight can be regarded even worse than the blind. They become so helpless and dependent for practically every activity of their daily life.

They are usually most co-operative in the efforts made towards their rehabilitation. The speed and facility with which they master the intricacies of artificial arm usage continues to be a source of wonder and admiration.

To expedite rehabilitation and create the desired confidence, the arm amputees, specially the forearm amputees, should be encouraged to use their stump as much as possible. So tendency for the nurse, the ward orderly and the relatives to feed them should be resisted. For example, a spoon can be bandaged to the stump, by means of which the patient can feed himself.

As no two patients are alike, mass production of artificial arms, except a few component parts of standard design, is not possible. Prescription therefore, depends on the patient's physical disability, profession, age, weight and other individual peculiarities. Besides plaster cast,

moulds are prepared and measurements taken on special measure charts.

TYPES OF ARTIFICIAL ARMS/HANDS

The upper arm prostheses can be mainly categorized as follows :

(a) COSMETIC DRESS HANDS

As the name implies, the cosmetic arms/ hands are mainly for cosmetic/show purposes. These have no functional value. These are mostly carved out of wood or laminated with PVC resins. In India, mostly cosmetic hands are used.

(b) MECHANICAL HANDS

Although, Mechanical hands vary in design, their basic principle remains the same. After World War I, there was a tendency to duplicate in an artificial hand, all the motions of the natural one, including pronation, supination, and flexion and extension of the wrist. They were complicated and cumbersome. Fortunately, the present designs are comparatively much simpler, light and provide mechanical, features essential for proper functioning. Most mechanical hands are new made with two or four fingers mounted on a common axle with the thumb mounted on a separate axle or lever, running parallel to the finger axle. The covers may be made of wood, fibre glass, plastic moulded, aluminium or a combination of these materials.

There are two types of mechanical hands in common use. One is the voluntary muscle control type in which the fingers and thumb are held in extension by a light spring and are closed by muscle control from the opposite shoulder. Thus, the movements of prehension in the artificial hand are under the direct muscle control of the patient. The other which may be described as the spring tension hand is held in a closed position by means of a strong spring within the hand. The fingers and thumbs are forced apart against this spring by a pull applied from the opposite shoulder; when this pull is released, the fingers and the thumb close to oppose each other. With practice, an amputee-specially a below Elbow case, is able to duplicate many of the motions of the natural hand. Pronation and supination, as well as flexion and extension at the wrist at rarely used in the present day arm prostheses because experience has shown that these functions do not add much to its functional value but greatly add to its weight and complexity. Generally speaking, the only useful function that is essential is that of prehension between the thumb and the fingers.

(c) CINEPLASTIC AMPUTATION AND PROSTHESES

In the case of cineplastic amputation, the remaining muscles in the stump are utilized to activate the prostheses. This method of activating an artificial arm was first originated in Italy in 1897 and is reported to have ben applied to wounded soldiers from the abysissian Campaign. Although, the Italians continued to contribute towards its development, it was in Germany, after World War I, that Prof. Saurbruch developed the essential principles of the modern cineplastic amputation and established a practical technique of the method.

The muscles are utilized by mean of ivory/ plastic pegs, passed through/tunnels in the muscles and attached to levers operating the artificial hand mechanisms. The bicepss and triecps muscles in the upper arm stump and the flexors and extensors in the forearm stump, control the grasp and release of the fingers of the artificial hand, thus permitting a close approximation to the natural hand action.

Although, cineplastic prostheses were used in Europe and some in the USA, these are no longer popular even in those countries, mainly because of the weight of the prostheses and discomfort in the stump. In most cases, the patients develop irritation in the muscular tunnels/due to the friction caused by the plastic/ ivory pegs. This type has NOT even been attempted in India.

(d) EXTERNAL POWER SOURCES

Only two types of external energy are know

to have been seriously considered for prosthetic uses: electrical and pneumatic. The latter was found unsuited for artificial arms because of the weight required for structures capable of withstanding the necessary operating pressures. A few years ago, an artificial arm, operated by small cylinders of highly compressed carbon dioxide was developed in Germany but little is known about its success.

(e) MYO-ELECTRIC OR ELECTRONIC DEVICES

Recently, a number of attempts have been made, specially in Germany, to utilize electrical energy through the medium of electro-magnets. The earliest arm of this type was constructed in Germany after the first World War. Since then, several independent inventors have constructed hands on this principle most notable amongst them being M/S Otto Bock Orthopaedic Industry in West Germany. From utility point of view, it has not really proved very successful.

(f) TERMINAL DEVICES/APPLIANCES

Notwithstanding the development and research in artificial arms/hands, the fact remains that terminal devices or working appliances cannot be dispensed with. These are used all over the world and have several designs to suit each occupation or profession of an arm amputee, i.e. a table spoon to farming and universal appliances for doing heavy, manual jobs. Each patient gets a set of these, depending upon his occupation/profession. A Split Hook or Dorrence Hook is invaribly given to all. These are either snap fitted or screwed on the rotaries.

(g) COSMETIC GLOVES

As mentioned earlier, in the rehabilitation of upper extremity amputee, not only is it necessary to restore the lost function, it is also important to restore the appearance. For this purpose, generally a Cosmetic Glove is provided which is worn over the artificial hand. The glove is made after constructing moulds for a shape as complex and detailed as the human hand. The life of a cosmetic glove depends on its use by the wearer.

(h) APPENDAGES/SUSPENSION FOR UPPER EXTREMITY PROSTHESES

Some sort of suspension or an appendage is necessary for all types of upper extremity prostheses to suspend/secure the same to the stump. They also act as the muscular substitute or artificial tendons which utilize the powerful muscles of the shoulder and trunk to control and operate the prostheses. These appendages are normally made from cotton webbing or leather or a combination of both. These are designed

An arm amputee, plying a rickshaw with the aid of Nevedac mechanical hand

A bilateral arm amputee, eating and drinking with her mechanical hands.

separately for each type of arm disability.

CONCLUSIONS

Rehabilitation of upper extremity amputee poses much greater and complex problems. Even though research and development even in the highly industrialized countries have been going on for several decades, there still is no prosthesis that can meet the needs of the arm amputees. In India, this subject has unfortunately remained practically neglected mainly because of the confusion created by some that we should have simple type of appliances.

Our designs should be as upto date as possible, keeping in view the economic and occupational/professional needs of our amputees, areas and environments to which they belong cosmetically presentable and our designs should, thus be need based. The Govt. of India, Ministry of Welfare Scheme for providing free or subsidised aids/appliances to our physically handicapped persons is quite liberal and flexible. This and other schemes of the Government plus help from philanthropists, provide enough incentives to look forward to modernization in this field.

At the same time, the Government should encourage and liberalise the import of samples, materials and techniques from other countries.

Stress must also be laid on proper training in the use of the artificial arms. Every efforts should be made to put him back in his original profession and near to his original place of work or residence. Failing this, he should be taught a suitable trade or hobby, to make him economically independent. In the case of bilateral arm amputees, they can be easily trained and employed as office peons, chowkidars and painters/decorators.

The thrashers cannot and should not be banned, but Government can enforce safety measures through proper legislation.