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Indigenous Socket Adapter for Endoskeletal Trans Radial Prosthesis

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ABSTRACT

Most of the upper extremity transradial prosthesis consists of exoskeletal system which makes the prosthesis comparatively heavy and also takes more time for fabrication. Current designs of commercial arm prostheses do not support a modular approach. The purpose of this study was to design and develop a low cost socket attachment unit for endoskeletal transradial prosthetic system (ranging from very short below elbow to wrist disarticulation) which will help in increasing and decreasing the length of the forearm bar (pylon) of the prosthesis easily as per the requirement. The socket adapter was made from aluminium alloy with internal threading of M12*1.75. As the wrist unit was eliminated and light weight materials were used for fabrication of prosthesis, the weight of the prosthesis was about 0.506 kg as compared to 1 kg for conventional prosthesis. After fitting the prosthesis, patient was able to open the terminal device at any desired elbow flexion and wrist position. The novel socket adapter design will allow the Endoskeletal idea to be used in the construction of upper limb prostheses.

Keywords: Transradial prosthesis, Endoskeletal, Modular, Socket adopter, Aluminium alloy.

INTRODUCTION

Technological development in any field is primarily based on the needs of the Human intellect. Human mind is always engaged in the research and he applies many innovative ideas to design and developed several modern gadgets to make his life as enjoyable as possible. In prosthetic science, this phenomenon also works and reflects through an age of iron and copper to an age of light and ultra light weight prosthetic devices. Generally, the conventional upper extremity prosthesis consists of exoskeletal system. For this it makes the prosthesis comparatively heavy and also takes more time in order to fabricate transradial prosthesis. Patient also requires more body strength to operate the prosthesis. The rejection rate for upper limb, body powered prostheses are always high. [1] But these problems can be solved by adapting a modular concept. Commercial arm prosthesis does not now allow a modular approach, which means that a personalised arm becomes an assembly of different devices.[2] There is another aspect, which brings a revolutionary change in the P&O arena i.e. development of components based on Modular concept. These components are prefabricated and permit easy maintenance and repair. Besides this fact, the technology reduces fabrication time considerably.

Existing Designs:

In the United States, there are now two endoskeletal upper-limb prosthetic systems available. They're made up of tubular humeral and forearm pieces with cosmetic foam covers. The completed prosthesis provides a high degree of

cosmetic acceptance after final shaping and covering with a skin-colored stockinette. Modular prostheses are less in weight than traditional prosthetic limbs, in addition to providing better cosmesis and softness. These Endoskeletal Upper Extremity Prostheses, on the other hand, are merely aesthetic in nature. [3] Passive or cable-operated elbow flexion with manual locking is possible with the Otto Bock Pylon Arm device for transhumeral and shoulder disarticulation amputees. Rotation adaptors are used to passively place the humeral segment in internal or external rotation, as well as the forearm in supination or pronation. The system hands include cable-controlled, voluntary-opening or -closing components, as well as a passive hand unit with a spring-activated thumb and fingers. The Otto Bock system has two friction-loaded, passively positionable shoulder parts for shoulder disarticulation: a ball-and-socket joint and a flexion-extension, abduction-adduction hinge. [3] Components for transradial, trans-humeral, and shoulder disarticulation levels of amputation are included in the Hosmer-Dorrance Corporation's endoskeletal system. The Hosmer-Dorrance system is compatible with any terminal device that has a W-20 thread. The humeral and forearm segments can be rotated passively using socket attachment turntables. Manual prepositioning of the terminal device in flexion is possible using a separate wrist unit. [3]

METHOD

The study was conducted in between Feb-2014 to Feb-2015 at SVNIRTAR, Odisha.

Design concept:

The design of this socket adapter was based mainly on the concept of making light weight endoskeletal transradial prosthesis with modular approach. The socket adapter was made from a alloy aluminium with internal threading of M12*1.75. The unit was very simple in construction with outer knurling section for bonding with thermoplastic while doing moulding.

Modifications and its purposes:

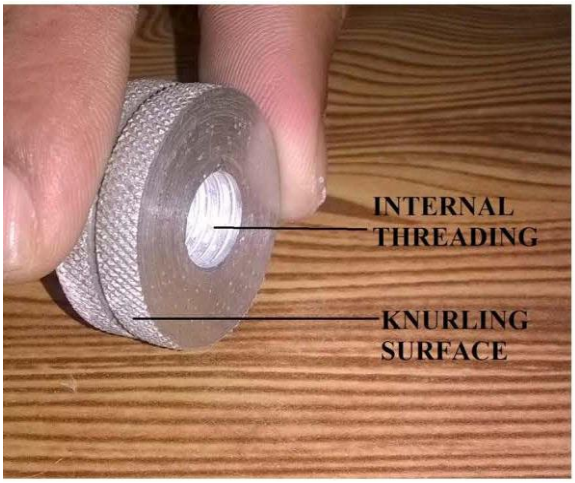

Fig 1. Parts of Adapter

Fig 2. Square groove and Tie groove

At first, the aluminium rod of 1 ½ inch dia was shaped by a lathe machine by keeping the outside diameter 30 mm, inside diameter 10.2mm and the thickness of the unit was 12mm. On its outer surface there was a tie groove in the middle having 2 mm width and 2 mm depth for holding the socket during suction molding or lamination. Both side of the tie groove was knurled in order to create secure bonding between the adapter and socket, so that to prevent slippage. The front side of the adapter was made of a square groove having 25 mm width and 4 mm depth. The purpose

of this groove was to mount of the adapter directly over the positive mould for alignment. In its inner diameter, 12 mm threading was done in order to receive 12 mm dia bolt. The square groove was created for placement of the adopter over the positive modified mould with POP solution.

Clinical trial with the newly designed socket adopter:

A 22 years old, male patient having 12 cm residual limb length (Right transradial amputee) was taken for clinical trial of the newly designed socket adopter. Casting was done by using 10 cm plaster of paris (POP) bandage. Then it was poured with POP solution and rectification was done. The socket adapter was placed over the mould directly in such a way that the normal sagittal axis of the mould and the normal frontal axis of the adapter were perpendicular to each other. Then the polyethylene sheet of 6 mm thickness was draped over it. The socket was trimmed as per the normal trim line of the transradial socket design.

Fig 3. Alignment of adopter over the positive modified mould

Attachment of components:

Fig 4. Polyethylene moulded socket with 12mm rod

Fig 5. Inside view of socket

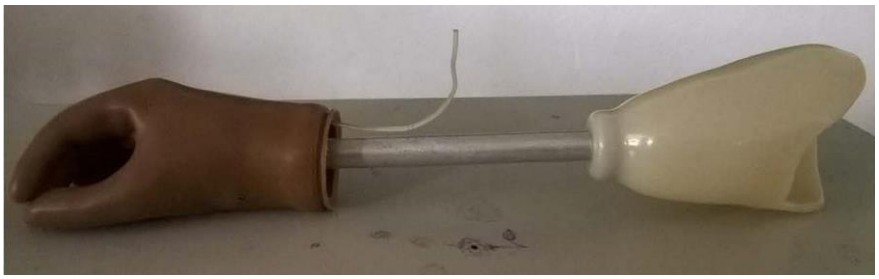

Fig 6. Endoskeletal Transradial Prosthesis

At first, a 12 mm threaded bolt was tightened with the distal end of the socket. Then at the other end of the bolt, an internal threaded 12 mm diameter aluminium tube of

appropriate length was attached and fixed with the bolt by riveting which representing the forearm length. The distal end of the aluminium tube was directly attached to the terminal device eliminating the use of a wrist unit in order to reduce weight. Then the modular BE prosthesis was finally covered with a soft foam ethaflex cover. Finally, a cosmetic glove was attached to the prosthesis.

RESULT

The weight of the prosthesis was only 0.506 kg, compared to 1 kg for a traditional prosthesis, due to the elimination of the wrist unit and the use of light weight materials in its manufacturing. The patient was able to open the terminal device at any desired position of elbow flexion after the prosthesis was fitted, and he was able to do a variety of tasks with ease.

DISCUSSION

It is necessary to acknowledge a fundamental fact regarding the amputee community. Geriatric amputees have distinct needs than younger amputees, as is commonly acknowledged. In consequence, the natures of the amputee community and the principles guiding prosthesis creation have shifted, but prosthetists and prosthesis developers have been reluctant to notice. The great majority of amputees' needs are covered by endoskeletal modular prosthetic systems by their mere nature. [4] The major advantage of this endoskeletal prosthetic system is for paediatric amputee. Patient need not to change the whole prosthetic system except the socket when the age progresses which ultimately reduce the repetitive cost. Any damage component can be easily replaced instantly without changing the whole prosthesis. The pylon length can be easily extended as per the requirement. As the weight of the prosthesis is significantly reduced, patient will accept the prosthesis as an integral part of the body and can perform task specific activities effectively and efficiently. [5] The aesthetic view of the prosthesis is very pleasing because the cosmetic cover is made up of ethaflex liner which will behave as forearm muscles. It is the established concept of using the endoskeletal technique for fabrication of Lower extremity prosthesis. [6] However in application of the concept for upper limb is yet to be followed.

CONCLUSION

The new design of socket adapter will give rise to implementation of Endoskeletal concept in fabrication of Upper limb prosthesis. This is very much cost effective as in large scale manufacturing; each unit may cost 10 to 20 rupees. The overall cost of Transradial Prosthesis will not increase. Not only the prosthesis will be very light in weight but also it reduces the fabrication timing as well.

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Conflict of Interest: None

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