Cost Effective Transradial Assistive Prosthetic Hand

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Abstract: ***As the number of amputees continues to grow in low resource settings, their demand for prosthetic devices continue to be unmet. Consequently, these amputees face exhausting physical, emotional and economic challenges like navigating unfriendly terrain, emotional trauma, loss of income, and social rejection on daily basis. While there have been attempts to meet this demand, the challenges in doing so are difficult and complex. Many organizations, including government and nongovernmental organizations (NGO's) and private entities are trying to deliver low - cost and durable prostheses to amputees. However, all of these organizations face a wide array of challenges related to infrastructure, technology and business in achieving this goal. Rehabilitation is the stepping stone to help an individual to start or return to his or her education, work and day-to-day living. In the context of prosthetic devices and amputees, rehabilitation has the potential to compensate for an amputee's lost limb(s) and sustain that function over a period of time. To improve the chances of successful and continued prosthesis use, rehabilitation should begin immediately after 3-4 week wound-healing phase following amputation and include training on proper use of prosthesis. The prosthetic device will then require maintenance over time and adjustments according to the patient's needs. Thus, for optimum use and comfort, the patient would need to travel a number of times to maintain his or her device. To compensate for these issues, it is preferable to make prosthesis affordable, locally accessible and able to be manually constructed and repaired and functional without being too technically advanced. Designing a prosthetic device specifically for amputees in developing countries is the key to widespread adoption of technology, which should be both low cost and culturally appropriate. Further work should examine not only the design of an appropriate prosthesis but also the methods by which it can be manufactured and distributed to reach the greatest number of users.***

Keywords: Transradial Prosthesis, Terminal Device, Control cable system

1. Aims and Objectives

- To provide a comfortable fitting device for the stump.
- To provide light weight device.
- To fabricate the device in less time.
- To provide the cost effective device.
- To provide a device that is useful to the patient for activities of daily living.

2. Methodology

Design and Construction: The low cost transradial prosthesis is designed in such a way that it can be constructed / fabricated with minimum expenses in less time. Also the maintenance cost can be reduced as the device doesn't require much maintenance.

Availability of the Materials Used: Most of the materials used are recyclable and they can be easily purchased at very low cost from any local market.

2.1 Materials Used

1) Bicycle Brakes
Two most common types of brakes are rim and disc brakes. Parts of bicycle brakes:
- A mechanism for applying force into the system (typically brake levers).
- A mechanism for transmitting that force (cables).
- A breaking mechanism such as a caliper.

Working of a bicycle brake: The user applies force into the breaking system for example by pulling the brake lever. Then force is transmitted through the system, for example via cables that connect lever to caliper. Ultimately the force is transmitted into the caliper where the caliper clamps the brake pads onto the braking surface.

Figure: A bicycle brake

2) PVC Pipes (Polyvinyl Chloride Pipes)
Polyvinyl chloride comes in two basic forms: rigid and flexible. The rigid from of PVC is used in construction for pipes and in profile applications such as doors and windows. It is also used in making bottles, food covering sheets, bank cards, etc. It can be made softer and more flexible by addition of the plasticizers. In this form it is also used in plumbing, electrical insulation, etc. Pure PVC is white, brittle solid.

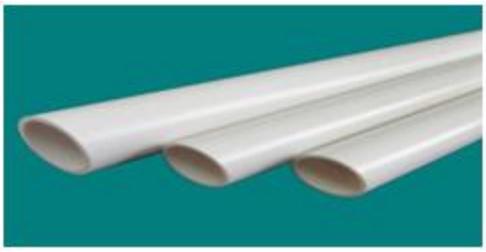

Figure: Polyvinyl chloride pipes

3) Plastic Bottles (Soft Drink Bottles)

A plastic bottle is a bottle constructed from high density or low density plastic. These bottles are typically used to store liquids such as water, soft drinks, motor oil, medicines, milk, shampoo, etc. The size ranges from small bottles to large carboys. Plastic bottles became very popular because of their lightweight nature, relatively low production and transportation costs as compared to glass bottles. However, the biggest advantage over glass bottles is their superior resistance to breaking in both production and transportation. These bottles can be recycled and used to manufacture new products like new bottles, container, etc.

Figure: A plastic bottle

2.2 Fabrication Procedure

Step 1- Remove the bottom of the bottle and place over the plaster model. Then apply heat to the lower portion to form the trimline.

Step 2- Heat the bottle until it conforms to the shape of the plaster model. Ensure that the bottle has fully conformed to the shape of the plaster model.

Step 3- Add another bottle over it, repeat the heating process & cut the trimlines.

Step 4- Cut the PVC (Polyvinyl chloride) pipe according to the residual forearm length. Attach the bicycle brake to it.

Step 5- Heat the PVC pipe and insert it in the plastic bottle cap so that it can contour the cap's shape. Remove the PVC pipe once it contours the shape of the bottle cap. Make a mixture of resin, cobalt blue and hardner and cover the inner side of PVC pipe with the mixture and carefully insert the pipe in bottle cap.

Step 6- Make a harness and attach the cable of bicycle brake into the hanger of the harness.

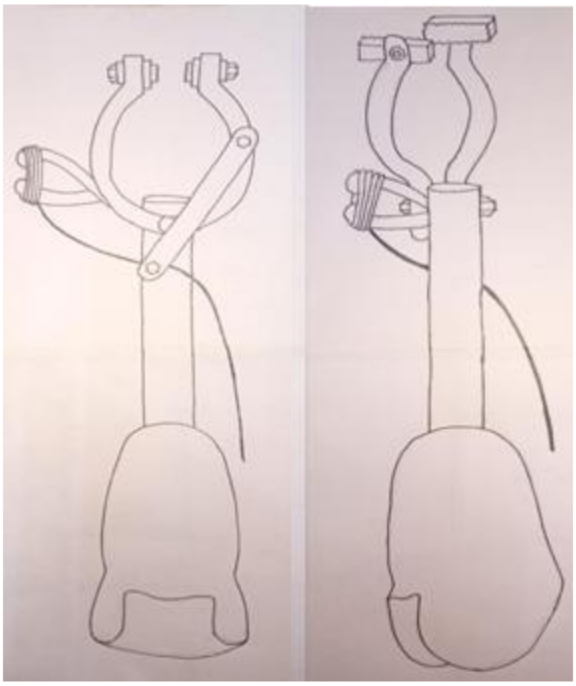

Figure: Front view and Side View of the Transradial Assistive Prosthetic Hand

Training

Once the device has been appropriately selected and constructed, the individual needs instruction in its use and care. A training program should teach the application, use and maintenance of the device and allow the individuals sufficient time to master each of these factors which are believed to influence learning should be considered, such as the user’s attention span, need for reinforcement, level of verbal and written comprehension and ability to retain and generalize information. The user should first learn to apply and remove the device properly and as independently as possible. Throughout this training program, the device should be periodically rechecked and modified for proper fit and mechanical functioning.

Advantages

- It is light in weight.
- The plastic socket can be dried easily after activities like bathing, toileting, etc.
- Adjustments can be easily done.
- Materials used are inexpensive.
- Cost required for the maintenance can be reduced.
- Materials used in making of the prosthesis are easily available in any local market.
- Most of the materials used are recyclable.
- Time required for fabrication is reduced.

3. Conclusion

The formed prosthesis is durable, and it provides an alternative solution for making costly prosthetic devices to meet the functional needs of many trans-radial amputees. Being light in weight the patient can easily use the prosthesis frequently without any hindrance. Since the fabrication procedure takes less time for the manufacturing of the socket, so saving of the time is an advantage and availability of the material is not a big problem. Most of the parts used are recyclable hence cause less damage to the environment.

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