NOVEL UPPER LIMB PEDIATRIC PROSTHETIC DESIGN: A CASE STUDY

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INTRODUCTION

The decision to fit a child with a prosthesis at an early age is a complicated matter. Varied rates of acceptance and rejection have been reported. Studies have indicated lack of function and lack of comfort as reasons for rejection (Wagner et al., 2007 & Postema et al., 1999). When presented with the challenge of fitting a child with bilateral absence at the elbow the authors strove to design a prosthesis system that would address these two concerns.

METHOD

Presented is a case study of a boy with bilateral congenital absence at the elbow. At the time of initial evaluation he was four and half months old. In a review of relevant literature the authors found little guidance on what to fit for this patient's presentation. Prosthetic componentry appropriate for the patient's age and level of amputation were limited. A variety of novel solutions were created.

Passive Prostheses

At seven and a half months the patient was seen for initial fitting of passive prostheses. The prostheses utilized roll-on silicone liners and lanyards secured on the lateral frame for suspension. This method allowed the parents to quickly don the liners and secure the prostheses and eliminated the necessity of a harness.

Available pediatric elbow components available did not provide internal and external rotation while maintaining an appropriate prosthetic elbow hinge center. A pair of passive positional joints with detent resisted motion, previously designed for use as adult finger joints, were used for the elbow hinges. The diminutive size of the joints allowed them to be mounted to the forearm section in which the humeral section could rotate.

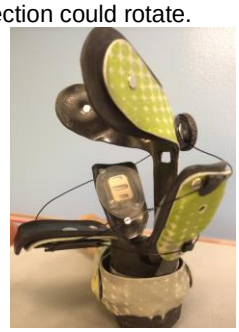

Figure 1. Myoelectric Prosthesis

Figure 2. Patient at 22 months of age

Myoelectric prostheses

At 18 months of age the patient returned for initial fitting of myoelectric devices. The adjustability of the sockets was a larger concern as it was important for these devices to be usable for a longer period of time. Donning accuracy was also an inherent concern as skin and electrode contact was necessary. Lanyard suspension was again used. Holes were cut into the roll on liners to allow for skin contact with the electrodes. In order to maximize volume adjustability free floating panels of rigid frame and socket were created from the anterior, posterior, and medial walls. A BOA™ mechanical lacing system was utilized to create the closure. The resultant socket and frame system was very flexible and adjustable while also being firm and stable during use. Ease of donning and doffing was improved due to the increased visibility to the channels for the lanyard. The parents were able to visually confirm the location of the holes in the liner and manually position the electrodes during the donning process. This drastically improved the repeatability of electrode contact.

A new larger joint was designed and fabricated to provide a detent resisted motion similar to the previous joints but able to resist the greater weight of the terminal devices. The joint was affixed to the forearm section with a single pivot point distally that allowed approximately 45 degrees of rotation in both internal and external rotation.

RESULTS

Passive Prostheses

The passive prostheses were accepted well by the patient and no signs of distress or discomfort were noted. The patient was able to "hold" objects and in most cases chew on them. Patient and parents preferred unilateral wear times as the contralateral limb was available for sensory input. Normal range of motion maintained.

Myoelectric prostheses

As with the passive devices the patient showed no signs of distress and tolerated donning and wear well. Normal shoulder range of motion was observed. At 22 months of age the patient demonstrated active operation of terminal devices in order to grasp objects. Bilateral wear times were more common and tolerated.

DISCUSSION AND CONCLUSION

The designs presented were successfully integrated into daily life by the patient and the parents. The custom nature of the components used provided the pathway to success. Finding creative ways to maximize function and comfort does not guarantee continued use but does provide the best opportunity for successful prosthetic usage.

CLINICAL APPLICATIONS

This case has clinical relevance to pediatric upper limb prosthetic fittings.

REFERENCES

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