INCREASES IN ROM AND CIRCUMFERENCE OF THE FOREARM AFTER 6 MONTHS OF USING A 3D PRINTED TRANSITIONAL HAND PROSTHESIS

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INTRODUCTION

Children’s prosthetic needs are complex due to their small size, constant growth, and psychosocial development (Krebs et al., 1991 and Zuniga et al. 2015). Independent of the type of limb deficiency (congenital or traumatic) muscle atrophy, loss of mobility, and asymmetry are typical characteristic of the affected limb (Krebs et al., 1991 and Zuniga et al. 2015). Most upper-limb prostheses for children include a terminal device, with the objective to replace the missing hand or fingers. Electric-powered units (i.e., myoelectric) and mechanical devices (i.e., body-powered) have been improved to accommodate children's needs, but the cost of maintenance and replacement represent an obstacle for many families (Krebs et al., 1991 and Zuniga et al. 2015). The development and use of low-cost transitional prosthetic devices to increase ROM, strength, and other relevant clinical variables would have a significant clinical impact in children with upper-limb differences. Thus, the purpose of the study was to identify anthropometric, active range of motion, and strength changes after 6 months of using a wrist driven 3D-printed transitional prosthetic hand for children with upper limb differences.

METHOD

Subjects: Five children (two girls and three boys, 3 to 10 years of age) with absent digits (one traumatic and four congenital) participated in this study and were fitted with a low-cost 3D-printed prosthetic hand.

Apparatus: Anthropometric, active range of motion, and strength measurements were assessed before and after 6 month of using a low-cost 3D printed prosthetic hand.

Procedures: Six variables from the affected and non-affected hand including circumferences, skin folds, and active ROM for flexion, extension, radial deviation, and ulnar deviation were measured on each research participant by a trained occupational therapist.

Data Analysis: Seven separate two-way repeated measures ANOVAs [2 x 2; hand (affected versus non-affected) x Time (before and after)] were performed to analyze the data. A p-value of \( \leq 0.05 \) was considered statistically significant for all comparisons.

RESULTS

There were significant hand x time interactions for the forearm circumference [F(1,4) = 16.90; p = 0.02], active ROM flexion (Fig. 1) [F(1,4) = 12.70; p = 0.02], and active ROM extension values [F(1,4) = 8.80; p = 0.04]. There were no significant hand x time interaction, however, for wrist flexion strength [F(1,4) = 1.48; p = 0.29], wrist extension strength [F(1,4) = 0.05; p = 0.84], active ROM UD [F(1,4) = 0.65; p = 0.5], active ROM RD [F(1,4) = 1.77; p = 0.25], and forearm skinfold values [F(1,4) = 4.24; p = 0.11].

DISCUSSION

The main finding of the present investigation was that the usage of a low-cost 3D printed transitional prosthetic hand significantly increased forearm circumference (Before=16.70±1.86 cm and After=17.80±1.48 cm), wrist active ROM flexion (Before=54.60±14.48° and After=68.40±14.29°), and active ROM extension (Before=40.40±37.75° and After=47.00±36.42°) on a small sample of children with upper-limb differences. Thus, the Cyborg Beast transitional prosthetic hand represents low-cost prosthetic solution for those in need of a transitional device to increase ROM.

CONCLUSION

Although, durability and environment are factors to consider when using 3D printed prostheses, the practicality and cost effectiveness represents a promising new option for clinicians and their patients.

CLINICAL APPLICATIONS

Six month of using this 3D printed transitional prosthesis increased forearm circumference, wrist active ROM flexion, and active ROM extension in children with upper-limb differences.

REFERENCES
