A Preprinting Protocol for Designing a 3D-Printed Prosthesis for a Young Child With an Upper Extremity Difference

Margaret Berger, OTD, OTR/L[1], Meredith Gronski, Matthew Foreman

[1]*Methodist University, Fayetteville, North Carolina, United States*

DOI: 10.5014/ajot.2022.76S1-PO10

Date presented: April 1, 2022

Primary Author and Speaker: Margaret Berger, mberger52@gmail.com

Over one thousand infants are born each year with upper extremity differences, creating challenges in essential occupations for childhood development in both home and school settings (Brown & Gordan, 1987; Egilson & Traustadottir, 2009; Parker et al., 2010). Research shows that such children can encounter barriers in ADL performance, play activities, and social interaction (Brown & Gordan, 1987). The use of assistive technology (AT) is one means of compensating for occupational deficits and promoting functional participation. Three-dimensional (3D) printing is an emerging area in occupational therapy and rehabilitation science for creating AT due to its customizability and cost-effectiveness in comparison to commercially manufactured equivalents. Current evidence shows that 3D-printed AT can be used to create devices that are more comfortable, fit better, have increased ventilation, and have more aesthetically pleasing features than commercially manufactured devices (Ganesan et al., 2016). The purpose of this project was to develop a pre-printing protocol for assessing, selecting, and designing a 3D-printed prosthetic device for a young child with an upper extremity difference. One participant was included to determine the feasibility and to inform changes to the pre-printing process in an iterative manner. The participant was a 3.5-year-old child who was born prematurely with a transverse upper extremity difference due to amniotic banding and was delayed in functional skills as a result. Parent goals included the ability to actively grasp objects with the affected extremity during play activities, as his current prosthesis was passive. Standardized, quantitative assessment measures were utilized to assess occupational performance, participation, and quality of life of the participant, with qualitative information gathered through parent interview. Anthropometric measurements of the upper extremity were recorded in order to ensure proper sizing of the printed prosthesis. A prosthesis design (The UnLimbited Arm v2.1 - Alfie Edition) was identified from an online repository and customized according to anthropometric measurements of the unaffected hand and upper extremity. Individual parts were printed (5th generation MakerBot Replicator) and assembled with an inexpensive hardware kit (Phoenix Hand by e-NABLE Assembly Materials Kit). Assembly resulted in a final prototype that was deemed appropriate for use with the participant according to initial parent interview. The end product of this project is a specific, novel design protocol that can be implemented for the proper selection and customization of 3D-printed prostheses for children with a variety of upper extremity differences. This project demonstrated that it is feasible to assess, select, and design an affordable and usable 3D-printed device utilizing occupational therapy perspectives in a customized manner, with the resulting protocol having the ability to positively impact the method of production of upper extremity prostheses across the occupational therapy profession. Future work should assess the impact of 3D-printed upper extremity prostheses on occupational performance, participation, and quality of life in young children to determine potential functional implications.

References

Brown, M., & Gordan, W. A. (1987). Impact of an impairment on activity patterns of children. *Archives of Physical Medicine and Rehabilitation, 68*(12), 828-832. https://pubmed.ncbi.nlm.nih.gov/2962558/?%2F

Egilson, S. T., & Traustadottir, R. (2009). Participation of students with physical disabilities in the school environment. *American Journal of Occupational Therapy, 63*(3), 264-272. https://doi.org/10.5014/ajot.63.3.264

Ganesan, B., Al-Jumaily, A., & Luximon, A. (2016). 3D printing technology applications in occupational therapy. *Physical Medicine and RehabilitationInternational, 3*(3). https://www.austinpublishinggroup.com/physical-medicine/fulltext/pmr-v3-id1085.php

Parker, S. E., Mai, C. T., Canfield, M. A., Rickard, R., Wang, Y., Meyer, R. E., Anderson, P., Mason, C. A., Collins, J. S., Kirby, R. S., Correa, A., & National Birth Defects Prevention Network. (2010). Updated national birth prevalence estimates for selected birth defects in the United States, 2004-2006. Birth Defects Research. *Part A, Clinical and Molecular Teratology, 88*(12), 1008–1016. https://doi.org/10.1002/bdra.20735