CMBES/SCGB
2025 CMBEC47/ACCES26
Fredericton, NB
May 27-29, 2025
ACCES

Preliminary Characterization of Transradial Prosthesis Alignment

K. Meng[1,2], C.C. Ngan[1], J. Andrysek[1]

[1] *Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada*
[2] *University of Toronto, Toronto, Canada*

ABSTRACT

A transradial (TR), or below elbow, prosthetic device is an artificial limb designed to replace the function of a missing upper extremity. However, there are several barriers to accessing quality prosthetic care, including a scarcity of highly trained prosthetists, long turnaround times, and material-intensive manufacturing processes[1]. Recent advancements have shown that digital technologies, such as CAD software and 3D printing have the potential to provide better-fitting devices while reducing clinician resources[2,3]. Despite these advancements, no methods for digitally designing TR prostheses have been fully integrated into clinical practice. The lack of literature on conventional TR prosthesis design makes it especially difficult to translate into digital workflows. The alignment, described as the precise position of the prosthetic components relative to the socket and arm, is critical for proper fit and function[4]. However, conventional alignment practices remain largely subjective, relying on the expertise of each prosthetist. This research aims to leverage digital technologies, such as 3D scanning, to quantify conventional alignment practices and translate these insights into data-driven digital workflows.

This study addresses these challenges through two objectives. First, semi-structured interviews with prosthetists reveals that alignment strategies often involve a combination of visual approximations and quantitative tools. Guiding lines are drawn on sockets to approximate wrist placement, supplemented by measurements such as the distance from the olecranon to the thumb tip and tracings of the contralateral limb. Common adjustments include medial wrist positioning and incorporating approximately five degrees of flexion and adduction to improve control. Prosthetists emphasized the relationship between function, cosmesis, and body symmetry, noting that deviations are highly case-specific and informed by collaborative discussions with patients. Second, imaging protocols were developed to quantify alignment using 3D scanning. This involves exploring two potential methods of measuring alignment for their relevance and repeatability: a global reference, which positions the prosthetic wrist in relation to a constant such as landmarks on the body or the contralateral limb; and a system reference, which aligns components using a joint and link biomechanical model. Preliminary testing demonstrated the feasibility of these methods for examining measurable trends. In one case study, the prosthetic limb was 19 mm longer than the contralateral limb, contrary to prosthetist expectations of maintaining body symmetry. Angular measurements indicated prosthetic adduction and pronation between 1-12 degrees, aligning with prosthetist reported practices.

This work establishes a foundation for ongoing analysis with a larger sample size, which will refine statistical models correlating measured alignment patterns with qualitative prosthetist input. By bridging conventional and digital approaches, this research provides quantitative insights which may be used for education and the development of data-driven digital workflows, ultimately improving the efficiency and effectiveness of TR prosthesis design.

Keywords: Digital Technology, 3D Scanning, Transradial Prosthesis, Alignment, Digital Design

Conflict of Interest: The authors declare that they have no conflict of interest.

REFERENCES

1. Biddiss E, Chau T. Upper-limb prosthetics: Critical factors in device abandonment. *Am J Phys Med Rehabil*. 2007;86(12):977-987. doi:10.1097/PHM.0b013e3181587f6c
2. Ngan CC, Sivasambu H, Kelland K, Ramdial S, Andrysek J. Understanding the adoption of digital workflows in orthotic & prosthetic practice from practitioner perspectives: a qualitative descriptive study. *Prosthet Orthot Int*. 2022;46(3):282-289. doi:10.1097/PXR.0000000000000107
3. National Academies of Sciences E and M. *The Promise of Assistive Technology to Enhance Activity and Work Participation.* (Jette AM, Spicer CM, Flaubert JL, eds.). https://www.ncbi.nlm.nih.gov/books/NBK453290/
4. Copeland C, Reyes CC, Peck JL, Srivastava R, Zuniga JM. Functional performance and patient satisfaction comparison between a 3D printed and a standard transradial prosthesis: a case report. *Biomed Eng Online*. 2022;21(1). doi:10.1186/s12938-022-00977-w