Preliminary characterization of rectification for transradial prosthetic sockets

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Abstract— Achieving proper socket fit is crucial for the effective use of a prosthesis. However, digital socket design lacks standardization and presents a steep learning curve for prosthetists, as the transition from palpating the limb and working with hand tools to manipulating a model on a computer screen was a significant and intimidating change [1]. While research has focused on digital socket design for the lower-limb population, there is a research gap in upper-limb socket design. This study aimed to characterize the design (rectification) process for the transradial socket, specifically the three-quarter Northwestern-style design, towards the development of a more systematic, data-driven socket design approach. Fourteen (n=14) pairs of unrectified and rectified plaster models were compared. Six common rectification zones were identified through shape analysis, with zones of plaster addition being the most prominent in terms of volume and surface area. A novel 3D vector mapping technique was employed, which revealed that most of the shape changes occurred in the anterior–posterior and proximal–distal directions. Overall, the interquartile range of each rectification zone demonstrated reasonable consistency in terms of volume, surface deviation, and 3D vector representation. The initial findings from this study support the potential for quantitively modelling the transradial socket design process. This opens the door for developing tools for categorizing and predicting socket designs across diverse populations through the application of techniques such as machine learning. A similar approach has been successful for the lower-limb population. Dickinson et al. [2] previously analyzed and characterized the shape differences among 67 pairs of residual limb and rectified socket models, creating both statistical design models and combined limb shape and design models. These models were able to capture 95% of the population variation in 19 and 4 modes, respectively. This suggests the potential for generalized rectification trends using a computationally efficient method, potentially automating elements for prosthetic design.

Keywords— Prosthetics, Orthotics, CAD/CAM, Socket design, Digital technology

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