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3D Printing Method for Upper-Limb Diagnostic Sockets

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I. Introduction

3D printing (3DP), is an ever-evolving technology enabling rapid prototyping and custom design. One promising application is in the fabrication of prosthetic sockets [1]. Currently, prosthetic limbs are designed using manual methods, such as plaster casting and plastic forming, which is time-consuming, and expensive [2]. A diagnostic socket is commonly used by prosthetists to assess and optimize the fit and comfort of the device on the patient before fabricating the definitive socket. As such, it must be transparent, rigid, and thermoformable [3]. However, a viable method for 3D printing a diagnostic socket meeting these criteria has yet to be established. Therefore, the objective of this study is to present a clinically viable approach to 3D print diagnostic sockets for upper-limb prosthetic devices.

II. Design requirements

A Fused Deposition Modelling (FDM) 3D printer was selected due to its accessibility, cost-effectiveness, and desired part properties [4]. Commonly used transparent filaments were evaluated. Polyvinyl butyral (PVB) is most similar to the traditionally used Polyethylene terephthalate glycol (PETG) sheets [5]. Printing parameters such as nozzle diameter, layer height, shell thickness, and number of perimeters were optimized to enhance transparency and rigidity. Finally, post processing techniques, such as smoothing the exterior surface with isopropyl alcohol, were explored to improve transparency.

III. Discussion

Five diagnostic sockets were 3D printed using PVB filament with specific printing parameters and underwent successful clinical assessments by prosthetists. Feedback from both prosthetists and patients confirmed that the 3D printed sockets met transparency, rigidity, and thermoformability criteria, making them a promising alternative to traditional sockets. This research underscores the potential of FDM 3D printing for affordable and accessible prosthetic socket fabrication, with implications for transforming traditional clinical practice to a digital process. Limitations and future work include exploring quantitative methods to assess and compare the rigidity and transparency of traditional methods versus 3DP methods.

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