

# Direct scanning the person's limb is the first step towards a more efficient and client-friendly way of making prostheses



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## Evaluating the Reliability of a Shape Capturing Process for Transradial Residual Limb Using a Non-Contact Scanner

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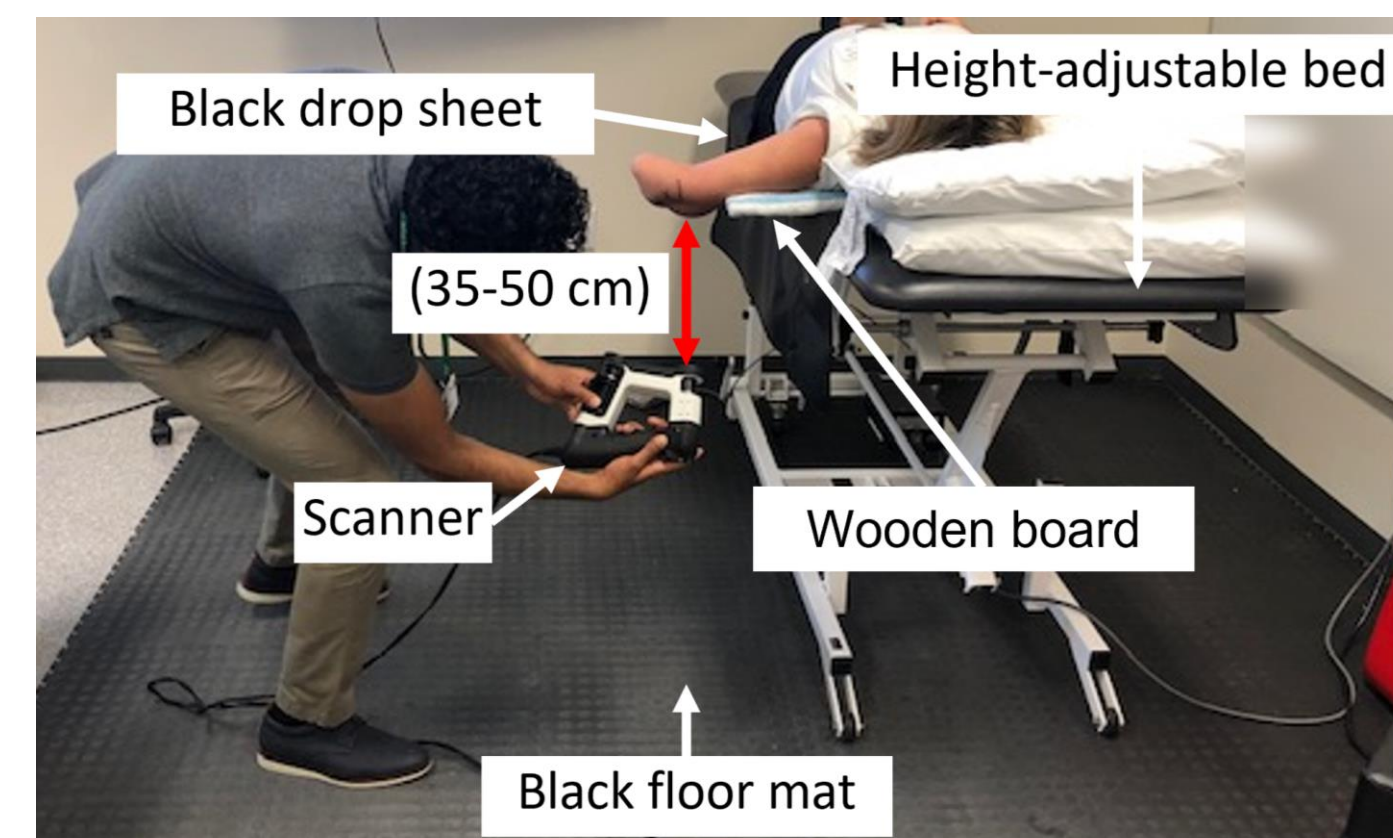
### Introduction

A non-contact scanner is used to digitally capture the shape of the residual limb. The generated 3D model can be used to monitor and quantify the change in shape and volume of the residual limb for accurate clinical assessment.

**Gaps:** 1) Previous studies only assessed scanner performance on lower limbs; 2) No established and/or validated clinical protocol for scanning upper limb, particularly transradial

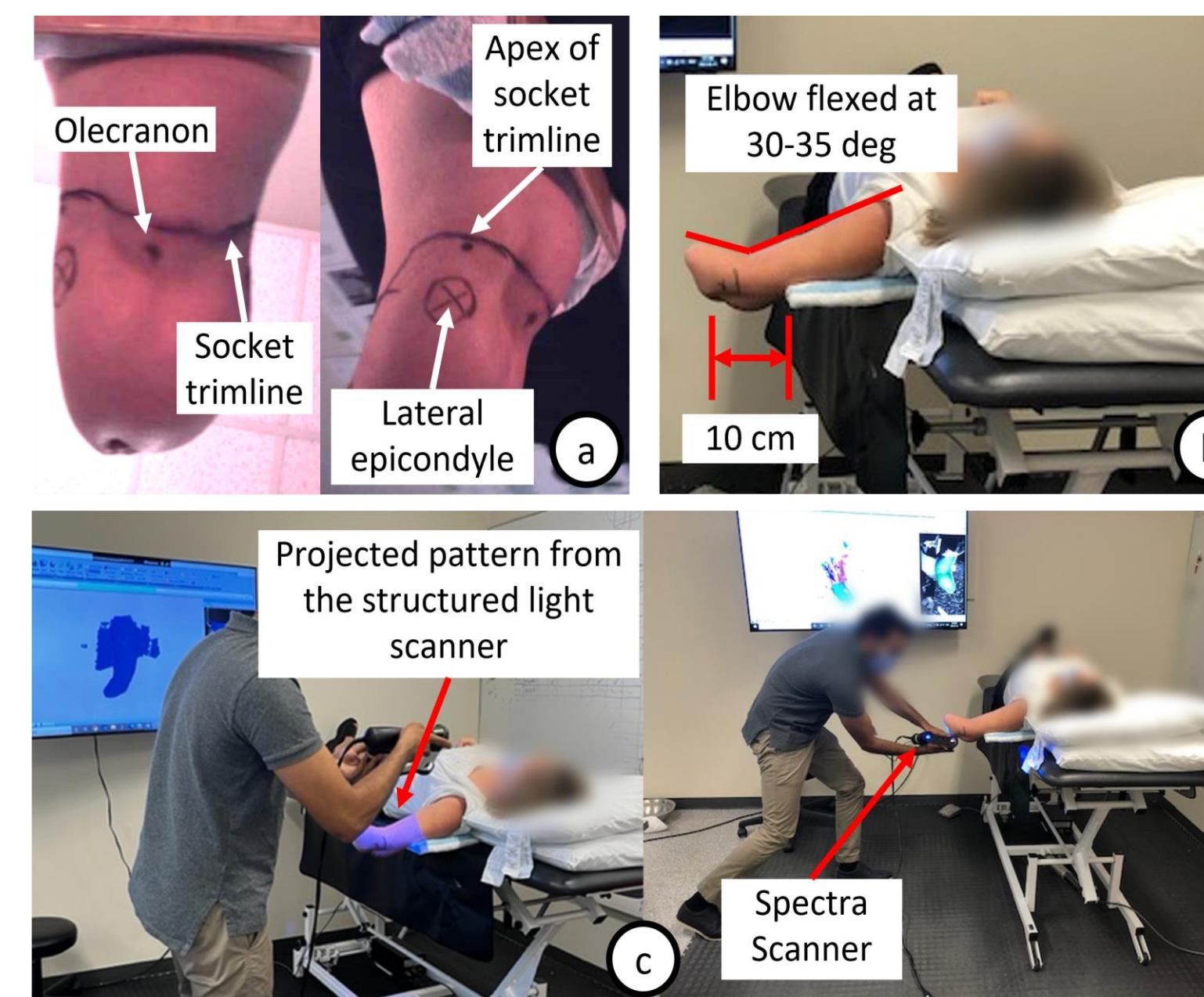
**Objective:** 1) Develop an optical scanner-based shape capture process for direct scanning of transradial limbs; 2) Assess the reliability of its volumetric and shape measurements

### Shape Capturing Procedure



The depiction of the main aspects of the shape capture setup showing the client (on the height-adjustable bed) and the individual performing the scanning.

(a) Key anatomical landmarks identified; (b) Limb absentee is instructed to lay supine on the bed; (c) The scanner is aimed at the residual limb directly above its surface, then moved in a steady and continuous manner around the residual limb.



### Evaluation of Reliability

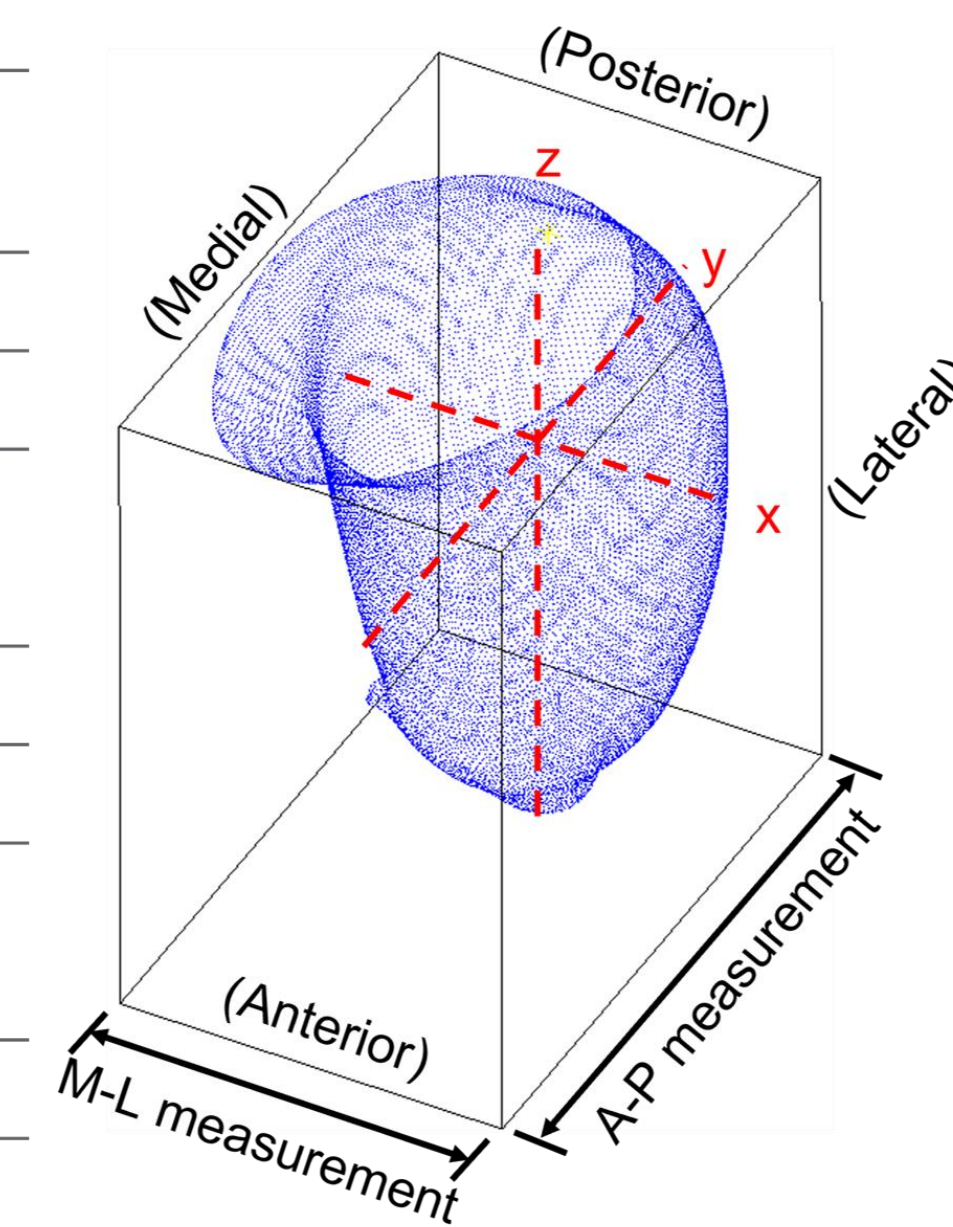
- 2 observers x 3 scans each = 6 scans per participant
- Intraclass Correlation Coefficient (ICC)
- Intra- & Inter-rater reliability was assessed on overall volume and shape measurements of the model
- A threshold of ICC > 0.90 was selected for the level of reliability [1]

### Results and Discussion

- 15 participants

	Observer	MD (SD)	ICC	95% CI
<b>Volume (mL)</b>				
Intra-rater	1	0.73 (12.21)	<b>0.999</b>	0.998–1.000
	2	1.60 (11.86)	<b>0.998</b>	0.996–0.999
Inter-rater	1 vs. 2	-2.75 (15.27)	<b>0.998</b>	0.995–0.999
<b>Overall M-L measurement (mm)</b>				
Intra-rater	1	-0.34 (0.99)	<b>0.996</b>	0.990–0.998
	2	0.09 (1.38)	<b>0.992</b>	0.981–0.997
Inter-rater	1 vs. 2	-0.80 (1.32)	<b>0.991</b>	0.981–0.997
<b>Overall A-P measurement (mm)</b>				
Intra-rater	1	0.49 (4.16)	<b>0.946</b>	0.880–0.980
	2	0.88 (4.35)	<b>0.926</b>	0.832–0.973
Inter-rater	1 vs. 2	-0.05 (7.71)	<b>0.918</b>	0.841–0.969

MD: mean difference; SD: 1 standard deviation; ICC: intraclass correlation coefficient; 95% CI: 95% confidence interval for ICC.



- The high intra- and inter-rater reliability suggests the scanning process has excellent reliability in volumetric and M-L measurements and that inadvertent movement of the limb can be controlled through proper positioning and supporting of the patient.
- Clinicians were concerned that the inherent size and volume difference between upper and lower limbs could impact the performance of the scanners [2]. But the results suggested that the developed scanning protocol can be used to capture small residual limbs without compromising the reliability of the measurements.
- The range of 95% CIs were too wide to conclude that the overall A-P measurement was reliable. But analysis revealed that the error originated from slight differences in elbow flexion between scans, and thus would not affect the clinically relevant portion of the residual limb.

[1] E. Seminati, D. Talamas, M. Young, M. Twiste, V. Dhokia, and J. Bilzon. "Validity and reliability of a novel 3D scanner for assessment of the shape and volume of amputees' residual limb models," *PLoS ONE*, 12, e0184498, 2017

[2] Ngan, C.C.; 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*, 282–289.