

DEVICE TO MEASURE THE DIMENSIONS OF THE HAND AND FINGERS FOR PRESSURE THERAPY GLOVES FOR BURNS PATIENTS

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INTRODUCTION: The accuracy of hand anthropometric data for the fabrication of pressure therapy gloves is critical to the healing process. This study proposes a new device using high speed photogrammetric technologies combined with identification and calculations algorithms. The measurements obtained with the device are evaluated through comparisons with manual measurements.

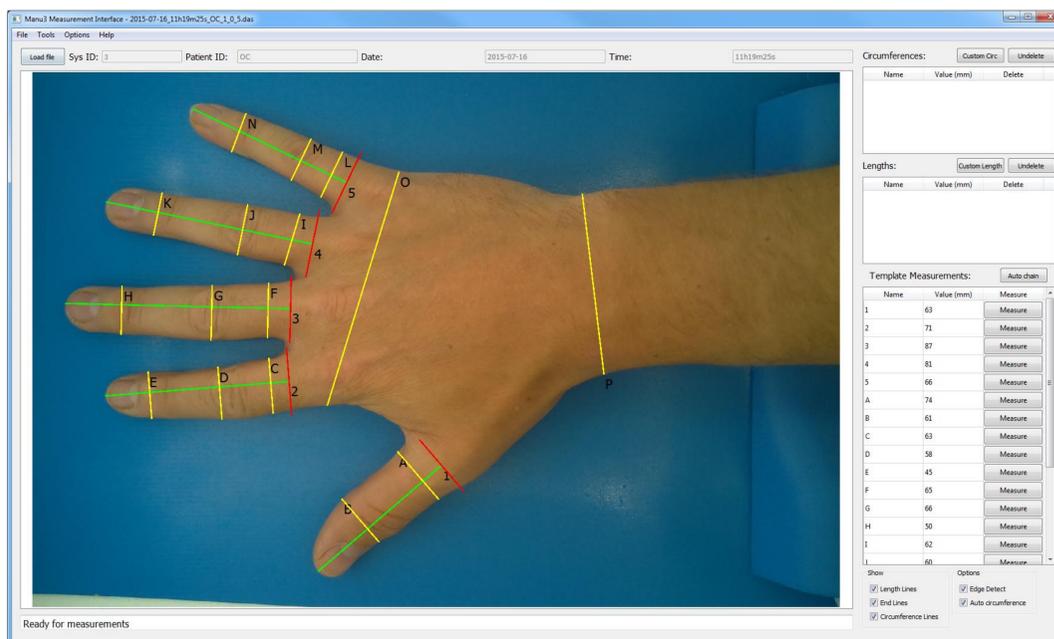
MATERIALS AND METHODS: Typical circumferences and lengths of fingers and hands of a representative population of ten (10) hands from five (5) individuals (1 female age 7, 1 female age 30-40, 2 males age 20-30, 1 male age 30-40) were measured:

- a) Manually by an experienced burns technician and by a non-experienced research engineer using a measuring tape
- b) By the analysis of images obtained with the MANU 3 (Anatomi Metrix, Montreal, Canada).

A quantity of three manual measurements with a standard measuring tape were taken from each hand by each measurer. The Manu3 was used to capture photogrammetric images that were then operated to provide calculated measurements. The same number of measurements were generated with three different captures of data with the device. Variability in measurements between the manual methods and the measurements generated from images taken with the device was determined using a Root Mean Square Error (RMSE) statistical method. These results were then compared to results reported by Yu et al. which evaluated two 3-D scanning methods (IM-II and IM-III) by comparison to manual measurements.



Manu3 Device



Photogrammetric Image with Analysis

RESULTS: An average RMSE of approximately 2mm compared to manual measurements and a repeatability of measurements within 1mm for linear measurements and 6mm for circumferences were obtained and compared to the 3D image capture data previously reported.

RMSE between instrument and manual measured finger circumferences			
	AVERAGE (mm)	MINIMUM (mm)	MAXIMUM (mm)
Manu3 image from 1 capture	2.02	0	5.67
3D image from 10 captures (IM-II)	4.51	1.97	8.51
3D image from 3 captures (IM-III)	4.29	0.82	10.08

IM-II and IM-III are from Yu et all (2013)

RMSE= Root mean square error

DISCUSSION: Previous comparisons of two and three dimensional imaging to manual measurements of finger and hand length and circumferences have shown acceptable agreement, suggesting photogrammetric methods can replace the standard manual method.^{1,2} RSME results of hand dimensions obtained with the Manu 3 technique are well correlated with manual measurements and show a marked improvement over photogrammetric measurements in recently published data.

CONCLUSIONS: This device provides the burns specialists with an easy to use, accurate, fast (20 ms) and contactless technique to capture the anatomical dimensions of the hand and fingers to provide the required measurements to design and fabricate pressure therapy gloves. This proposed technique experienced limitations primarily with hands that cannot lay flat with open fingers. Research is ongoing to address these limitations and to develop other hand related applications.

REFERENCES:

¹Yu, A., K. L. Yick, S. P. Ng, and J. Yip. "2D and 3D anatomical analyses of hand dimensions for custom-made gloves." *Applied Ergonomics* 44, no. 3 (2013): 381-392.

²Habibi, E; Soury, S, Zadeh, A. "Precise Evaluation of Anthropometric 2D Software Processing of Hand in Comparison with Direct Method." *J Med Sign Sens* 2012,3:195-256-61.