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Inter-device Consistency in 3D Burn Surface Estimation

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Abstract: The objective of this study was to estimate whether the Revopoint Miraco portable 3D scanner provides sufficient accuracy in comparison to the Artec Eva for measuring burn wound surfaces. A total of 26 anatomical regions were scanned in 11 patients. The results demonstrated good agreement between the two devices, with a mean relative difference of 4.1%. Additionally, the study assessed the advantages and limitations of each scanner in terms of operational workflow, user-friendliness, and portability.

Keywords: 3D scanning, burn wounds, surface measurement, Artec Eva, Revopoint Miraco

1. Introduction

Accurate assessment of burn size is a critical factor in clinical decision making, affecting surgical planning, fluid therapy, patient monitoring, and long-term rehabilitation [1,2]. Traditionally, methods such as the "rule of nines" and Lund-Browder plots have been used to estimate total burned area (TBSA). While these techniques are widely accepted, they rely heavily on visual estimation and are therefore susceptible to subjective bias and variation, particularly for burns in tortuous or anatomically irregular areas. [2,3]

Studies have shown that manual estimates of TBSA can vary widely between healthcare providers. Palmer et al. reported an average difference of 8.8% in TBSA estimates between referring and receiving hospitals, highlighting the limitations of traditional methods in ensuring consistency [6]. Furthermore, a recent study in the Journal of Burns & Trauma demonstrated that a smartphone-based 3D burns estimation tool had an average error of only 1.9%, while traditional methods had an error of up to 19.7%. [7]

To address these limitations, three-dimensional (3D) imaging technologies have become valuable tools in modern wound care. These systems can capture precise geometric and surface data of the wound, allowing for more objective and reproducible assessments compared to manual mapping or visual estimation [4,8]. Furthermore, 3D scanning allows precise documentation, aids in long-term monitoring of the healing process, and supports remote assessment in telemedicine. [9,10]

Various commercial 3D scanning solutions have been used in clinical and research settings. These include the Artec Eva, a well-established structured light scanner known for its high resolution and sub-millimeter accuracy [5,11]. More recently, lightweight, portable alternatives such as the Revopoint Miraco have emerged that offer practical advantages in the field or at the bedside, with integrated displays and battery-powered operation. [6,12]

Despite the increasing use of 3D technology in healthcare, comparative studies on the accuracy and clinical applicability of different scanners for burn diagnosis are

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still lacking. This study compares the measurement accuracy and reliability of Artec Eva and Revopoint Miraco scanners in quantifying burn wound surface in different anatomical regions. The results will clarify whether these devices are interchangeable in clinical practice and assess their usefulness in real-world burn care. [13]

2. Methodology

To obtain data, ethical approval was first secured, and informed consent was obtained from each patient. This study was approved by the Ethics Committee of AGEL Hospital Košice-Šaca (Slovakia) under the number 17-2023.

This article outlines the comparison of two 3D handheld scanners: Artec Eva and Revopoint Miraco, particularly the degree of agreement of the difference in measurement of the surface area of burn wounds across various body regions. This study aims to determine the degree of agreement between devices and highlights the potential for using more affordable devices in medical applications. In this study, the Artec Eva scanner was used as a reference device.

2.1. Study Population and Scan Locations

Scans were collected from 11 patients with clinically visible borders of burn wound areas and with different grades of burns on one or more body areas. In total, 26 wound areas were compared on these body regions:

- *Lower limbs- left (LLL) and right (RLL),*
- *Upper limbs- left (LUL) and right (RUL),*
- *Torso- anterior chest,*
- *Head and neck- face.*

2.2. Scanning Devices and Procedure

- *Two handheld 3D scanners were used:*
- *Artec Eva (Artec 3D, Senningerberg, Luxembourg) is a structured-light scanner with sub-millimeter accuracy designed for high-resolution applications.*
- *Revopoint Miraco (Revopoint 3D Technologies Inc., Shenzhen, China) is a compact, infrared-based scanner developed for fast and mobile 3D acquisition.*

All scans were performed in a controlled lighting environment. Patients were positioned to ensure the best possible visibility of the burnt wound with minimal body movement. Each wound area was scanned twice, once with each scanner, with minimal repositioning of the patient between sessions, taking their comfort into consideration.

Table 1: Technical specifications of scanning devices [5,6]

Technical Specifications		
Parameter	Artec Eva	Revopoint MIRACO
Type / Technology	Handheld, Structured-light 3D scanning	Handheld, quad-camera infrared structured light + RGB camera
Accuracy	up to 0.1 mm	up to 0.05 mm
Resolution	up to 0.2 mm	up to 0,02 mm (in certain modes)
Scanning speed / FPS	16 fps	up to 15 fps
Working distance	0.4 – 1.0 m	0.1 – 1.0 m
Capture area	Closest: 214 × 148 mm Furthest: 536 × 371 mm	Closest: 28 × 53 mm Furthest: 975 × 775 mm
Minimum / Maximum scan volume (object size)	Starting from 100 mm scale objects	Minimum: 10 × 10 × 10 mm Maximum: up to 4 × 4 × 4 m
Color / Texture	Full colour, texture resolution 1.3 MP	48 MP RGB camera, 8K colour capture
Onboard processing / hardware	Relies on external PC / workstation for processing	Standalone: has built-in CPU, RAM, storage
Display / UI	No onboard display (operated via PC)	No onboard display (operated via PC)
Battery / Power / Weight	Weight: 0.85 to 0.9 kg Power via AC or external battery pack	Weight: 750 g Internal battery (5,000 mAh) supporting up to 2 hours scanning

2.3. Data Processing and Surface Segmentation

Collected data from both devices were exported in the form of .obj mesh files, including the corresponding model texture. Mesh models were imported into freeware program Meshmixer (Autodesk Inc., San Rafael, California), for segmentation of burnt area. Segmentation in software was performed by one person, ensuring uniform measurement methodology in all scanned data files, independent of their native software capabilities.

The following steps were performed during segmentation:

- *Cleaning of surface meshes to remove scanning artifacts.*
- *Manual segmentation of burn wound areas using Meshmixer's surface selection tools.*
- *Extraction of segmented regions as standalone mesh objects.*
- *Surface area measurement (in mm²) using Meshmixer's built-in analysis and measurement tools (see Figure 1.).*

Figure 1: Segmentation and measurement of burned area.

2.4. Comparison and Statistical Analysis

For each burnt wound region, the following metrics were calculated:

- *Absolute difference (mm²):*

$$\Delta = \left| A_{Artec} - A_{Miracol} \right| \quad (1)$$

- *Relative percentage difference (%):*

$$\Delta\% = \frac{\left| A_{Artec} - A_{Miracol} \right|}{A_{Artec}} \quad (2)$$

- *Linear regression*

$$y = a + bx^2 \quad (3)$$

Where: y is the predicted (dependent) variable- measurement from the Miraco scanner; x is the independent variable- measurement from the Artec Eva scanner; b is the slope- it shows how much y change with a one-unit change in x; a is the intercept- the value of y when $x=0$.

3. Results and Discussion

Scans obtained from both devices were compared. From a total of 26 scans of body region collected from 11 patients' absolute difference and relative percentage difference were calculated. The surface area of each burn wound was calculated from segmented mesh models (see Table 2 and Table 3).

Results show a high level of agreement between scans across different body regions. The mean absolute difference in measured body area was 660.5 mm², with a mean relative difference of 4.1%. The highest calculated deviation (16.30%) occurred in a scan of the right upper limb of patient 25. In contrast, the smallest deviation (0.02%) occurred in a chest scan of patient 18, demonstrating consistency in areas with flatter topography. Overall, most scans showed a difference under 5%, indicating consistency between devices across anatomical regions.

To further improve statistical transparency, we also calculated the standard deviations and 95% confidence intervals (CI) for these measurements. The absolute difference demonstrated a standard deviation of 701.6 mm², with a 95% CI ranging from 390.8 to 930.2 mm², indicating moderate variability in the magnitude of measurement differences. The relative percentage difference showed a standard deviation of 4.14%, with a 95% CI of 2.48% to 5.66%, confirming that despite occasional outliers, the overall agreement between scanners remains strong.

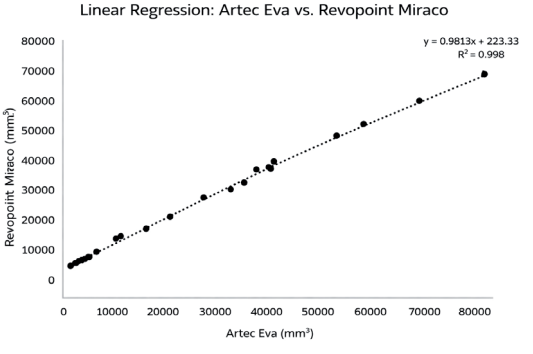

Figure 2: Chart of linear regression across all measurements

In all measurements, a strong linear correlation was observed between the two devices, with data points clustered closely along the regression line. The coefficient of determination ($R^2 = 0.99$) indicated

Table 2: Artec Eva vs. Miraco – Area Differences

Subject	Age/Sex	Burn Degree	Date	Body region	Surface area Artec Eva (mm²)	Surface area Revopoint Miraco (mm²)	Absolute difference (mm²)	Relative percentage difference (%)
17	58/M	II.	10.4.2025	LLL	9597.68	11098.8	1501.12	15.64
				RLL	50836.9	50174.5	662.4	1.30
18	60/F	II.	5.11.2025	LUL	35213.6	34913.4	300.2	0.85
				CHEST	46063.3	46055.2	8.1	0.02
			8.11.2025	LUL	33138.80	34402.5	1263.7	3.81
				CHEST	36040.20	37038	997.8	2.77
			13.11.2025	LUL	30773.6	28510.6	2263	7.35
				CHEST	4987.79	4960	27.79	0.56
			15.11.2025	CHEST	2226.05	2398.56	172.51	7.75
			12.12.2025	LUL	28879.20	27014.9	1864.3	6.46
				CHEST	1371.08	1461.29	90.21	6.58
19	65/M	II.-III.	6.2.2025	RUL	18756.8	18005.3	751.5	4.01
			10.2.2025		14489.3	13931.8	557.5	3.85
			15.5.2025		6572.45	6643.19	70.74	1.08
20	20/M	II.-III.	21.3.2025	FACE	5002.16	4932.94	69.22	1.38
21	49/M	II.	14.4.2025	LLL	71291.1	70 410.1	881	1.24
22	32/M	II.-III.	14.4.2025	LLL	59866.3	58496.7	1369.6	2.29
23	19/F	III.	10.4.2025	LLL	24021.1	24375.5	354.4	1.48
				RLL	1731.25	1771.35	40.1	2.32
24	42/M	II.	10.4.2025	LLL	3084.84	3048.6	36.24	1.17
			14.4.2025		1339.09	1402.02	62.93	4.70
25	52/M	I.-II.	29.4.2025	LUL	6991.73	6777.54	214.19	3.06
				RUL	10152	11807.2	1655.2	16.30
26	19/F	II.	12.12.2024	CHEST	4297.41	4323.58	26.17	0.61
			14.4.2025		3682.67	3838.09	155.42	4.22
27	48/M	III.	15.5.2025	RLL	35752.3	33974.8	1777.5	4.97
					Average		660.5	4.1
					Standard Deviation		701.6	4.14
					95% Confidence Intervals		390.8 – 930.2	2.48 – 5.66

Table 3: Artec Eva vs. Miraco – Area Differences

Body region	Absolute difference (mm²)	Relative percentage difference (%)
CHEST	211.1	3.2
LLL	70.9	4.42
RLL	826.7	2.86
LUL	1181.1	4.31
RUL	758.7	6.31
FACE	69.2	1.38

a high degree of agreement in the measurements and showed that the two systems functioned in a consistent and comparable manner (see Figure 2.).

Linear correlations were also calculated for different body regions. The strongest correlations were found in the chest region and lower limbs area (see Figure 3.), with coefficients of determination reaching R^2 = 0.99 (more precisely: R^2CHEST = 0.9997; R^2LLL=0.9995; R^2RLL=0.9991).

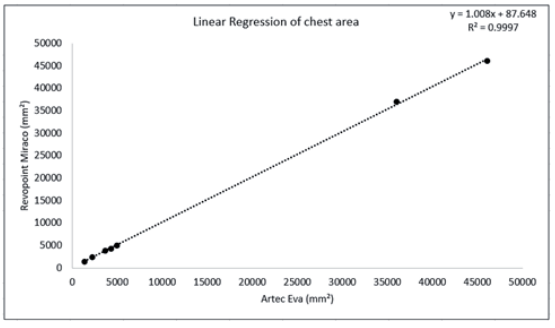

Figure 3: Chart of the strongest linear regression (chest area)

The most significant differences in correlations were found in regions such as the upper extremities, most likely due to the high complexity of the body regions and the curvature of the measurement area. The following coefficients of determination were calculated for the mentioned regions: R^2LUL= 0.9847; R^2RUL= 0.9649 (see Figure 4.).

The facial region was excluded from the regression analysis due to an insufficient number of data points, as the region was scanned only once in a single subject, using two different scanners; this exclusion was necessary to avoid unreliable statistical evaluation.

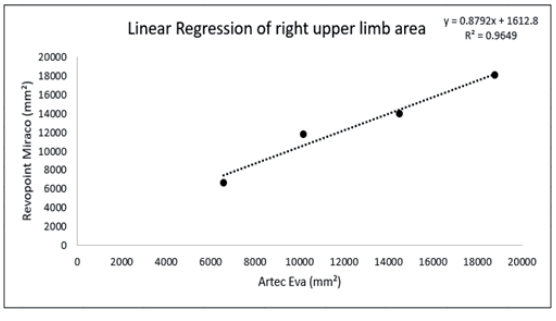

Figure 4: Chart of the lowest linear regression (right upper limb area)

Differences in measurement might be influenced by the color and texture range of captured 3D scans. Deeper colors were observed in models conducted by Revopoint Miraco, in contrast to scans form Artec Eva (see Figure 5.). Such variations may influence the visibility of wound margins during segmentation and subsequent monitoring of the healing process. For consistency, all screenshots were generated within the same software environment (Meshmixer).

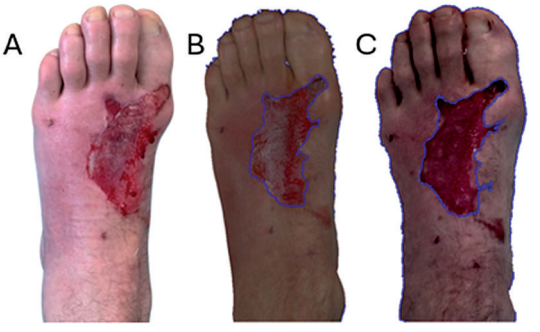

Figure 5: Differences in color and texture range of captured: A) photography, B) 3D scan by Artec Eva, C) 3D scan by Miraco of patient 24.

Additionally, aside from measurement accuracy, practical handling differences and ease of use were notable between the devices. Artec Eva requires a connection to a laptop and access to mains power. During a scanning session, the operator needs to monitor the laptop screen to ensure that the whole area was correctly scanned. This setup limits mobility and demands user training. Another disadvantage is the price of this device, where the base price, excluding licensed software can reach up to 14 000 €. [5]

In practice, the Artec Eva tends to be more reliable during scanning, it rarely loses tracking, and in most cases the scan is successfully completed on the first attempt, provided the patient remains still and no external interference occurs in the field of view. By contrast, the Revopoint Miraco is more prone to losing spatial orientation, which can lead to necessary repeated scanning attempts.

On the other hand, the Revopoint Miraco scanner does not require any additional devices or cable setups, as it is battery-powered and equipped with a touch screen. However, battery consumption is around 7% per scan, making it suitable for short-term use. The price of this device is around 1,500 €, which makes it more accessible for smaller clinics, and the software is provided free of charge with the device. Another limitation is the mesh model generation time, where with Miraco it takes 4-6 minutes on average, while with the Artec Eva completed post-processing is significantly faster, likely due to its PC-based

software. After a scanning session with the Miraco 3D scanner it is necessary to upload the collected scans to the PC or laptop for further processing and export. These differences may influence device selection, depending on whether speed or portability is the higher priority. [6]

Several previous validation studies have shown that modern 3D scanning technologies can achieve clinically acceptable accuracy in wound and burn assessment. Smartphone-based applications and dedicated wound-measurement systems demonstrated reliable burn size estimation, though some variability remained in areas with complex topography [7,8]. More recent work using handheld scanners in telemedicine and dermatology [9-12] similarly reported high precision, but highlighted challenges in capturing highly curved surfaces or irregular wound contours. Our findings align with these observations, with most measurements differing by less than 5%, and further extend the existing evidence by providing a direct comparison of two clinically accessible scanners in real burn patients. This supports the clinical feasibility of both devices for use in routine burn documentation and assessment.

4. Conclusions

This study confirms that the Revopoint Miraco 3D scanner can deliver reliable measurements of burn wound surface areas. Despite slight differences, the overall results of measurements show less than 5%. Revopoint Miraco turned out to be a convenient choice, especially while scanning chest or areas with flatter topography. These findings support the integration of portable and price friendly 3D scanning technologies into the routine of burn wound documentation and monitoring.

Future research should focus on using these scans to design and fabricate patient-specific compression orthoses that support scar healing, and on evaluating their fit, pressure distribution, comfort, durability, and clinical outcomes compared with conventional methods. In the long term, routine access to a 3D scanner within hospitals could allow burn units to capture accurate geometry directly at the bedside and immediately initiate the process of orthosis design. Alternatively, high-resolution 3D data could be easily shared with specialized fabrication centers, enabling remote production of customized compression garments without the need for the patient to travel. Such a workflow would streamline care, reduce delays, and make individualized scar-management solutions more widely accessible.

Acknowledgments

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