Reliability of Wound Surface Area Measurement of a Smartphone Application as Compared to Laser-Guided Planimetry and Manual (Linear) Measurement

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BACKGROUND:

Reliable wound measurement is essential to establish a baseline and track healing progress. Several techniques exist for measuring wound surface area (SA), however, they have various levels of reliability and accuracy. The most commonly used and traditional linear method, multiplying length by width (LxW), has been shown to over-estimate wound size by an average of 41% (Rogers, 2010).

Newer technologies, including the use of photo-planimetry software and smartphone applications, calculate SA by identification of the area within the wound perimeter. These methods offer the potential for non-contact measurement, greater accuracy, efficiency and enhanced clinical documentation. However, reports indicate variations in lighting, angle, clinician training, edge identification, tissue contour and wound size may impact precision and reliability. Few studies compared these measurement techniques using actual human wounds. Currently, no gold standard exists.

PURPOSE:

The purpose of this study was to compare the reliability of three different wound surface area measurement methods and to determine the reliability of novice raters using the smartphone application (app) and laser-guided planimetry methods.

METHOD:

DESIGN & SUBJECTS:

The design was a parallel forms reliability study involving novice and expert clinicians measuring 21 open wounds (16 males, 5 females; 53-95 years of age). The majority of wounds were venous leg ulcers (20); one was a vasculitic ulcer. Mean duration of the wounds was 13 months; surface area ranged from 0.43cm^2 to 15.25cm^2.

PROCEDURE:

Novice raters used a smartphone app (Tissue Analytics) and a laser-guided planimetry device (ARANZ Medical, SilhouetteStar®). On the same date, expert raters used a traditional (linear) method of greatest length by greatest width. Novice raters captured 2 images with each method. All raters were blinded to each other's measurements.

SMARTPHONE APP:

Figure 1. Smartphone application method of image capture.

Wound image was captured using the smartphone app on a portable device (Figure 1). The image was digitally sent to the software system. Wound L, W, and SA were determined by the software. A report was returned to the clinician within minutes.

LASER-GUIDED PLANIMETRY:

Figure 2. Laser-guided method of image capture using a hand-held camera.

The image was captured via hand-held camera (Figure 2) and uploaded to a computer. The clinician traced the wound perimeter using a digital stylus. The associated software calculated L, W and SA.

LINEAR METHOD:

Figure 3. Linear method of SA measurement.

A standard tape measure was used to determine greatest L and greatest W in centimeters (Figure 3). These measurements were multiplied to calculate SA.

DATA ANALYSIS:

SPSS, version 22, was used to determine intraclass correlation coefficients (ICC) for intra- and inter-rater reliability. SA calculations and raw LxW calculations were compared between methods.

RESULTS:

Intra-rater reliability, ICC(3,1), of novice SA measurements was excellent, .944 with the app and .998 with the laser-guided device. Inter-rater reliability for each method, using LxW and the calculated SA, was also excellent (Table 1).

	LxW	SA
App ICC (2,2)	.945 (.863 - .978)	.911 (.776 - .965)
Laser ICC (2,2)	.992 (.976 - .997)	.997 (.991 - .999)
Linear ICC (2,1)	.983 (.957 - .993)	.983 (.957 - .993)

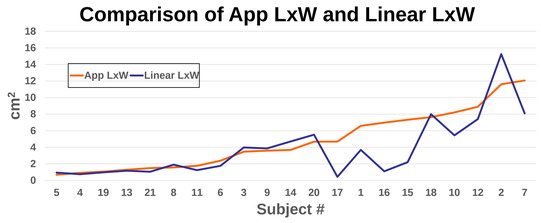
Table 1. Inter-rater reliability of all 3 methods.

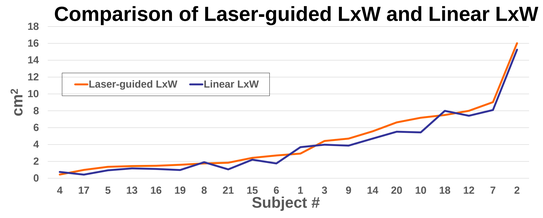
Excellent reliability was observed between methods using the LxW calculation (Table 2).

	LxW
Laser vs. Linear ICC(2,4)	.990 (0.940-0.997)
Laser vs. App ICC(2,4)	.873 (0.684-0.949)
App vs. Linear ICC(2,4)	.867 (0.665-0.947)

Table 2. Comparison of LxW between methods.

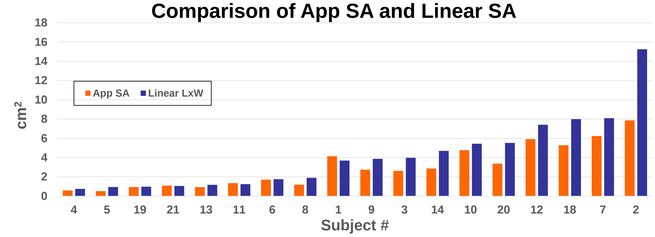
Regardless of wound size, there was close agreement between methods for the LxW calculation across nearly all subjects. Note slightly more discrepancy was observed with the app and larger wounds (Figures 4 & 5).

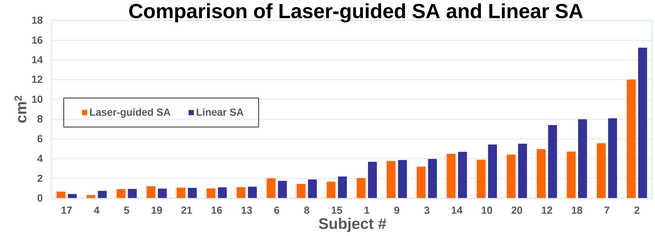




Figures 4 & 5. Comparison of LxW across subjects.

However, when comparing linear SA to the computed SA of the other methods, the linear method over-estimated SA in about 80% of cases (Figures 6 & 7).





Figures 6 & 7. Comparison of SA across subjects.

Seen below, the linear SA of subject 2 is almost double the SA calculated by the app. Note: image quality differs between methods. There also appears to be a slight discrepancy between human and software identification of wound borders (Figure 8).

Subject 2	App	Laser-guided	Linear
SA (cm^2)	7.87	12.03	15.25
LxW (cm^2)	11.11	16.02	15.25

Figure 8. Comparison of measurements for subject 2.

DISCUSSION:

Novice raters using newer measurement technologies achieved comparable reliability with experts using the traditional linear method. Consistent with the literature, the linear method tended to overestimate wound size when compared to SA calculated by the other methods. Lighting, wound positioning and image quality may affect reliability of computerized methods which do not involve human identification of the wound margin. While no gold standard exists, all methods were found to have excellent reliability; laser-guided planimetry having the highest reliability. Selecting one consistent method is recommended to reliably document wound measurements.