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Comparison of manual and digital wound planimetry techniques in full-thickness cutaneous wounds in dogs

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Abstract
The study was done to find the validity of different planimetric techniques in calculating wound surface area in dogs. Twelve dogs of different ages, breeds and sex brought to the University Veterinary Hospital Kokkalai, and Teaching Veterinary Clinical Complex, Mannuthy, with a full-thickness cutaneous wounds in various locations of the body due to different etiology were the subjects of study. Wound tracing technique and smartphone-based application Imito-measure were employed for the purpose of planimetry. Both methods of planimetry were found to be valid with comparable results.

Keywords: Cutaneous wound, wound planimetry, wound tracing technique, Imito-measure, noncontact method

1. Introduction

Wound planimetry represents a prime approach to wound evaluation, encompassing the measurement of the wound surface area to gain a comprehensive understanding of the healing progression. Wound healing is a complex, multistage process and the progress of which depends on multiple factors. Any impedance to the progress of healing will results in chronic wounds, severely affecting the quality of life of affected patients. Assessing wound size is crucial for tracking the progress of wound healing, appraising treatment impacts, and determining potential adjustments to the treatment approach when necessary. Wendland *et al.* (2017) [17] classified wound measurement methods as manual and digital methods. Estimation rulers, Kundin gauge and wound tracings are manual planimetric methods. The most straightforward and cost-effective approach to measuring surface area involves manually calculating the linear dimensions of a wound (i.e., length and width) using a ruler. Nevertheless, this method is time-intensive, and its precision and dependability may fluctuate due to the subjective judgment of wound boundaries. Consequently, owing to the declining cost of digital cameras, there has been a growing interest in utilizing photographic techniques for wound surface measurements. Digital methods involve digital planimetry, photogrammetry, deflectometry, and interferometry with the use of dedicated wound measurement devices like Mavis, Eykona, Silhouette and the Visitrak wound measurement device. Wang *et al.* (2017) [16] reported that the evolution of smartphone applications presents innovative solutions for addressing challenges concerning expenses and infrastructure of the above mentioned wound planimetric devices. Smartphones are extensively adopted, user-friendly and with improved camera capabilities making these gadgets an effective tool in carrying out planimetry of wound. Developing software that leverages these smartphone attributes enables users to capture precise and impartial images and measurements of wounds non-invasively. This advancement significantly enhances procedures for wound evaluation and treatment.

2. Materials and Methods

The research spanned six months, starting in February and concluding in July 2023. It focused on dogs presented to the small animal surgery out-patient units of hospitals of Kerala Veterinary and Animal Sciences University, Mannuthy and Kokkalai with a history of full-thickness cutaneous wounds.

Twelve dogs of different age, breed, sex, and body weight with full-thickness cutaneous wounds on different locations of the body were selected for the study. All the wounds were measured with two different methods on day of presentation and then on 7th, 14th and 28th days *viz,* manual method wound tracing technique and smartphone-based application Imito-measure app. In the wound tracing technique, the outline of the wound was drawn onto a transparent acetate sheet using a fine-tipped marker pen (Fig. 1). This traced sheet was then overlaid onto the graph paper (Fig. 3). The wound surface area was determined by tallying the number of grids covered on the graph sheet.] The surface area of wound was calculated from graph paper using the formula (Ne+0.40xNp) x0.25, where Ne and Np were the number of squares (0.25 cm^2) that lay completely (Ne) and partially (Np) inside the tracing Jyothi *et al.,* (2008) [7]. When utilising the Imito-measure application for measurements, an adhesive calibration marker with a diameter of 2 cm was positioned in proximity to the wound to calibrate the image (Fig.2). This calibration marker is provided along with the application. Subsequently, the camera of smartphone was placed about 20 to 30 cm away from the wound and the marker, maintaining a parallel alignment. A photograph was captured using the application, after which the wound edges were manually traced on the screen. To enhance precision, a touchscreen for Android phones pen was employed, which offer greater accuracy compared to using the fingertips of investigator. Subsequently, the application automatically computed measurements for the wound length, width, and surface area. Once calculated, a comprehensive report containing these measurements was generated and transmitted via email (Fig.4).

Fig 1: Tracing the wound edges on to a transparent sheet

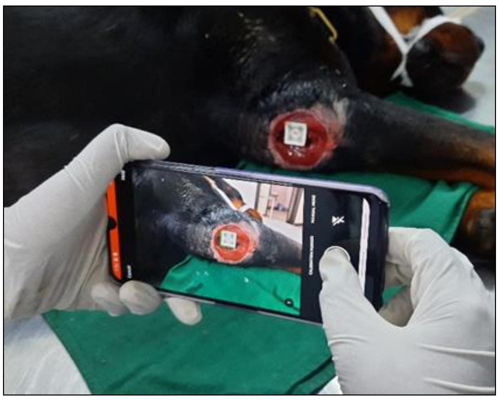

Fig 2: Wound measuring using the imito-measure app

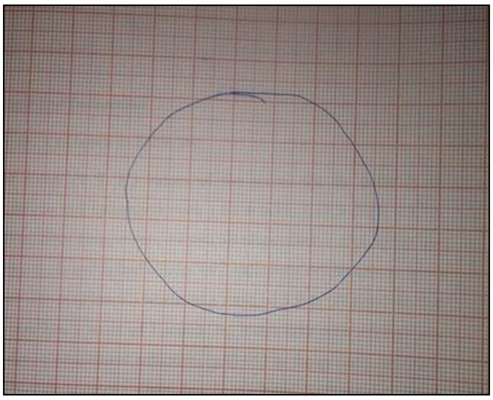

Fig 3: Tracings on transparent sheet transferred to grid paper

Fig 4: Measurement report generated by Imito-measure

A total of 96 measurements were obtained, using both methods during the period of study. Both methods yielded a total of 48 measures. The wound area (in mm^2) of same wounds were separately measured using two methods. Two methods were compared using Bland-Altman Plot for comparison of two wound area measurement methods. The correlation between the wound area measured by Pearson's correlation method and the variability, correlation coefficient and correlation plot. All the analysis was done using Graphpad Prism Software (V9.0)

3. Results and Discussion

3.1 Bland Altman Plot for comparison of two methods of wound area measurement

Upon analysis utilizing the Bland-Altman plot, several key observations were discerned regarding the comparative assessment of two measurement techniques. The central line, with a bias of -0.478261, closely approaches zero, indicating a high degree of similarity between the two measurement methodologies. However, the broad dispersion of data points surrounding the mean difference line suggests variability, implying that differences between the two methods may exhibit unpredictability. Furthermore, the absence of a discernible trend in differences across the range of mean measurements negates the presence of proportional bias, ensuring that the readings remain unbiased across both lower and upper measurement spectrums. This assertion is further bolstered by the observation that no data points lie outside the 95% agreement limits, ranging between -2.076 and 1.119. Hence the data indicates a general congruence between the two measurement methodologies for the given wound sets, with no significant variance observed.

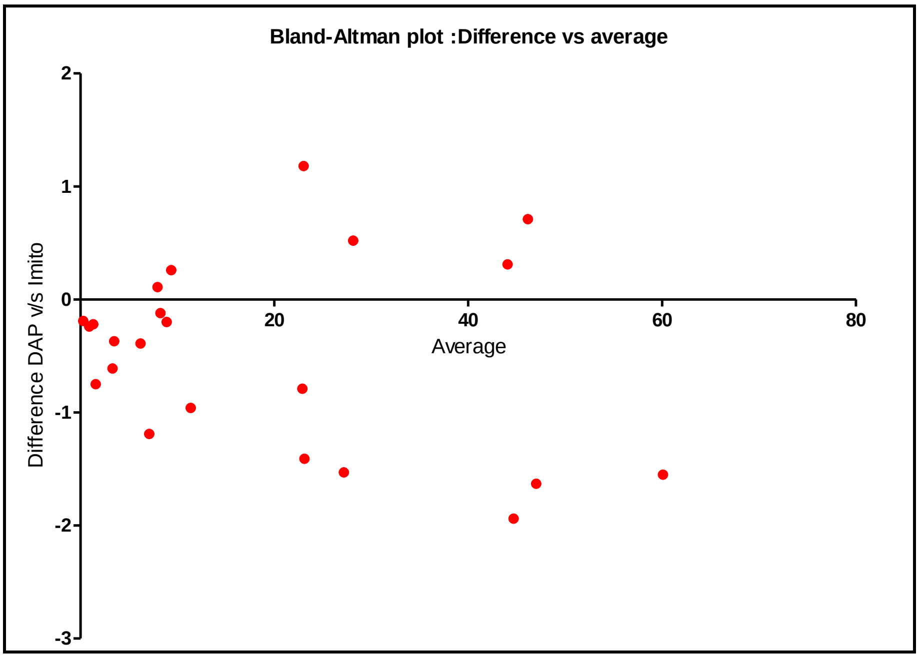

Table 2: Correlation between wound surface area as assessed by the Imito Measure app and the wound tracing technique

Pearsons r value	p- value	sig	R2
0.9991 (confidence interval 0.9977 to 0.9996)	<0.0001	S	0.9981

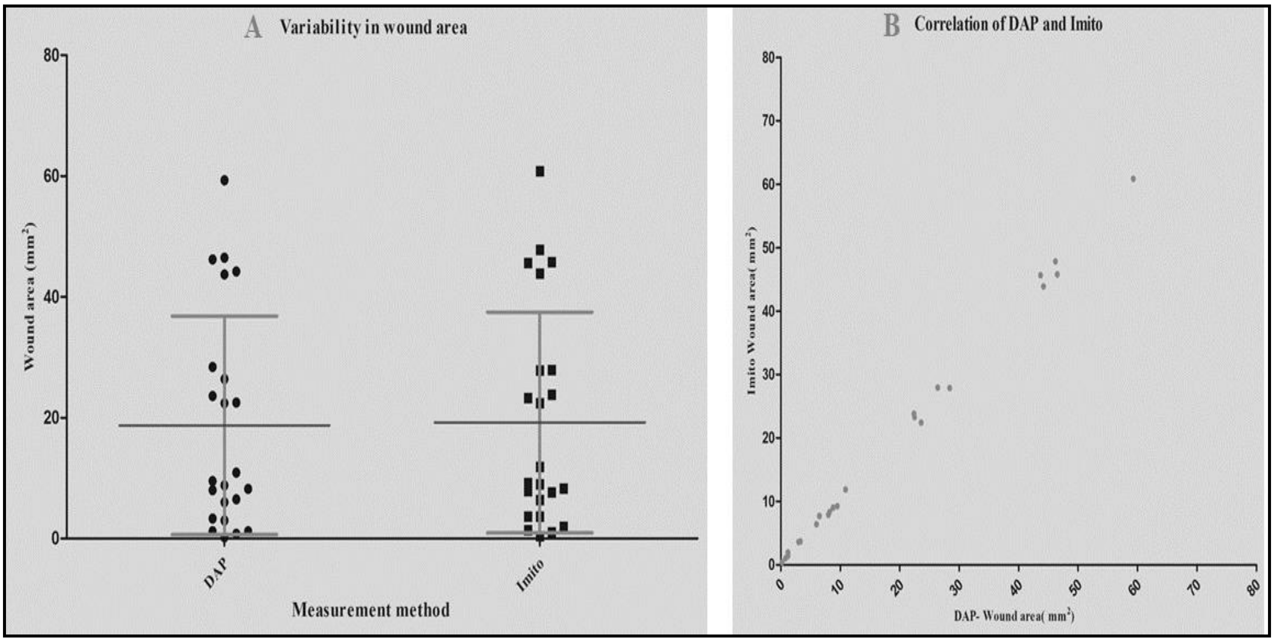

Fig 2A): Variability in measurement between DAP and Imito measure B) Pearson correlation curve of DAP and Imito-measure

From the Pearson correlation analysis it was evident that both wound planimetry technique has strong positive significant correlation (p =0.0001) since Pearsons r value is 0.9991 (confidence interval 0.9977 to 0.9996) and the correlation coefficient is 0.9981. The Pearson's r plot is almost linear with no outliers, indicating the closeness of values obtained from both measurements. Hence both methods give almost comparable values for measurement of wound area.

Any method involving direct contact carries the inherent risk of introducing contaminants to the wound bed, causing tissue damage, or inducing pain due to the direct interaction with the wound during the measurement process (Lucas *et al*., 2002) [12]. Adapting noncontact digital planimetric method, this kinds of difficulties related to contact methods can be avoided.

The strong relationship observed between the wound surface area measured through a smartphone application and the measurements taken using a metric graph sheet as detailed in Table (1), aligns with the outcomes reported by Younis *et al.* (2022) [18]. The study affirmed the validity and reliability of the Imito-measure application in quantifying the surface area of chronic lower-limb ulcers in human patients when contrasted with the manual tracing method. Similar results were observed by Do Khac *et al*. (2021) [8] during their research.

Accurate wound measurement holds significant importance within both acute and chronic wound treatment protocols. It serves a crucial role in assessing the effectiveness of therapies and predicting outcomes. As a metric employed to gauge the success of interventions, wound measurement establishes the initial data that clinicians rely on to evaluate wounds and monitor their progression toward healing (Sheng *et al*., 2018) [14].

The conventional approach to measuring wounds involves acetate tracing. This entails placing a clear acetate paper onto a gridded dressing, allowing for the manual computation of the wound surface area. However, this method is infrequently employed due to both hygiene concerns (direct contact with the wound) and its time-intensive nature (Van *et al.*, 2010) [15].

Smartphones with advanced high-definition digital cameras are now easily accessible at a relatively affordable price. The exceptional portability and mobility offered by these devices make them particularly attractive for clinical use (Ahmed, 2008) [1]. Imito and various other specialised smartphone applications have arisen to simplify and streamline wound measurement and documentation (Langemo *et al.*, 2015) [11].

Reifs *et al.* (2023) [13] conveyed the primary constraint of such 2D photography based wound planimetric techniques, related to characteristics of wound surface. When the wound curves or angles away from the plane of photograph or exceeds the capacity of camera lens the accuracy of area measurement and classification techniques becomes limited. To address this, additional photos from diverse perspectives are necessary for a comprehensive assessment. Furthermore, incorrect placement of calibration marker can introduce issues in the final wound measurement process.

The Imito-measure application is a noncontact digital planimetry application, providing an advantage compared with other methods. When capturing images of wounds, several crucial factors need to be taken into consideration. Initially, it is imperative to ensure that the calibration marker is aligned at the same level as the wound. This practice prevents any potential underestimation or overestimation of the actual area of wound. Additionally, the photographs should be taken directly focusing on the wound itself, without any axis deviation. A study revealed that even a slight deviation of 20 degrees from the optical axis of wound can result in a surface area underestimation of approximately 10 per cent. Lastly, when capturing the image, it is essential to position and adjust the image size on the smartphone screen to occupy the entire surface area accurately (Biagioni *et al.*, 2021) [5]. A study conducted by Aarts *et al.* (2023) [2] demonstrated excellent concurrent validity and reliability when using both the inSight® 3D device and Imito wound app for wound measurement. Both of these tools have been proven to be accurate, dependable, and feasible for assessing large postoperative wounds, including those situated on challenging-to-measure body surfaces. The researchers suggest that the inSight® 3D device is better suited for clinical research purposes, while the Imito Wound app is more suitable as a practical measurement tool in everyday clinical practice. Giggin *et al*., (2023) [9] observed employing smartphone digital planimetry through a smartphone dedicated application (Imito-measure) has proven to be beneficial for non-contact wound measurement in confined Asian elephants. This technique offers advantages such as its user-friendly nature, straight forwardness, rapid data generation and the capability to store and transmit information effectively.

Bodea *et al.*, (2021) [6] conducted research on the advantages of utilising a smartphone application for evaluating wound healing in feline patients. Their findings suggested that the Imitomeasure smartphone application could offer valuable assistance in wound assessment by streamlining the measurement of wound characteristics. This non-intrusive approach of this technology could potentially improve clinical procedures by eliminating any potential discomfort for animals, a contrast to conventional assessment methods.

Mobile applications and computer programs designed for wound area measurement can serve as effective alternatives to traditional methods due to their relatively high accuracy. These technological solutions offer several advantages, notably the substantial reduction in the time required for area measurements. Moreover, these technologies eliminate direct contact of materials with the wound, thereby lowering the risk of wound infection (Bokov and Mikhailov, 2022) [7]

4. Conclusion

The outcomes of this study led to the conclusion that the smartphone based wound planimetric technique using the Imito-measure application exhibited comparable reliability to the traditional wound planimetric method, specifically acetate paper tracing method. This suggests that the Imito-measure smartphone application could effectively serve the purpose of wound measurements with a level of dependability equivalent to the established technique. Given the rise of novel techniques and technological advancements, there exists an opportunity to measure additional dimensions of wounds. This subject currently occupies a central focus within the field of study.

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6. Conflict of Interests

There is no conflict of interest between authors.

7. References

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