



Figure 2. Procedure for using the Image Pro Express (Media Cybernetics, Silver Spring, Maryland) digital image analysis (DIA) software: (1) position target lesion toward camera at a set distance and toward a light source for standardization; (2) place ruler for calibration (present scale is in millimeters); (3) take digital photograph; (4) download image into computer running DIA software; (5) trace target, as demonstrated in this image; and (6) query DIA software to perform diameter and area calculations.

sources of measurement error for manual tracings, and in general, DIA provides a technology that can at least partially overcome these problems. Finally, it is important to note that DIA provides information beyond the quantitative evaluation of traditional manual tracings. Because DIA involves digital photography, it provides an image and thus a basis for objective evaluation of other end points such as infection, lesion thickness, granulation status, surrounding edema, and lesion progression over time, if used at sequential time points. Overall, additional studies are needed to further assess the uses of DIA in quantitative evaluation of other cutaneous lesions and beyond.

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Wound Assessment by 3-Dimensional Laser Scanning

Recent advances in our understanding of the biology of cutaneous tissue repair have influenced current therapeutic strategies for chronic wound management and will continue to influence chronic wound management strategies into the future.¹

An effective and accurate monitoring of skin lesions should be performed by measuring in an objective, precise, and reproducible way the complete status and evolution of the wound.² The main goal of current research projects is to design an easy-to-use technological system that can monitor the qualitative and quantitative evolution of a skin lesion.

This level of monitoring can be achieved by using 3-dimensional scanners: in particular, systems based on active optical approaches.³ There are 2 different areas of potential applications of such types of devices: in medical treatment (to improve the efficacy of therapeutic regimens)⁴ and pharmacologic scientific research (to assess the quality and effectiveness of new chemicals or clinical procedures).⁵

Methods. We prospectively examined 15 patients with venous leg ulcers. The patients who underwent sequential imaging of chronic wounds for this study all attended the leg ulcer clinic of the Wound Healing Research Unit at the University of Pisa, Pisa, Italy.

Our sequential imaging system is equipped with a Vivid 900 laser scanner (Minolta, Osaka, Japan), which is used for digitizing or scanning the wound shape. With regard to the calculation of the “external” surface and volume of a wound, it is necessary to assess its original shape to determine the missing volume virtually. At the time of patient presentation, information on the shape of the skin before the wound occurred is missing, and the technique for virtual reconstruction of the original wound surface must be as easy and user-friendly as possible. The system, relying on an analysis of the shape of the surface immediately outside the wound perimeter, creates an interpolating virtual surface that is continuously connected to the existing surface outside the wound and to that covering it.

The parameters we studied were the mean wound area (measured in square centimeters) and mean volume (cubic centimeters). To assess interrater reproducibility, scans were evaluated by 2 independent investigators. For assessment of intrarater reproducibility, a single investigator performed 2 consecutive measurements 5 minutes apart. Immediately after the first wound assessment of the first observer, a second observer, blinded to the findings of the first analysis, measured the same wound.

The means and standard deviations of duplicate determinations for each wound were used for analysis. The reproducibility of measurements was evaluated by means of an intraclass correlation coefficient (ICC) and its 95% confidence interval (CI).

Results. The measured total areas and volumes for independent raters and for subsequent measures of 1 rater are

Table 1. The Total Areas and Volumes of the Different Wounds Measured by the 2 Independent Raters and the 2 Measurements Made by the Single Rater^a

Wound Parameter	Rater 1		Rater 2
	Measurement 1	Measurement 2	
Area, cm ²	52.36 ± 8.5	51.26 ± 3.6	53.36 ± 8.4
Volume, cm ³	18.3 ± 2.6	18.6 ± 3.7	19.4 ± 4.6

^aAll data are reported as mean ± SD.

Table 2. Percentage Relative Error in the Measurements of Total Areas and Volumes and ICC of the Different Scans Between 2 Independent Raters and Within a Single Rater^a

Wound Parameter	Intrarater	ICC	Interrater	ICC
Area, cm ²	1.06 ± 0.66	0.9976	0.54 ± 0.39	0.9936
Volume, cm ³	1.96 ± 1.33	0.9832	1.44 ± 0.91	0.9714

Abbreviation: ICC, intraclass correlation coefficient.

^aUnless otherwise indicated, data are reported as mean ± SD percentage relative error.

reported in **Table 1**. No statistically significant differences were found between scans evaluated by the 2 investigators about wound area and volume. The relative errors and the intraclass correlation coefficients are reported in **Table 2**. The ICC values were excellent for both intrarater and interrater reproducibility with a very low relative error value. The mean ± SD time for a full scan acquisition on the wound area and volume was 3.6 ± 1.4 minutes.

Comment. The laser scanner system used in this study enables users to accurately acquire 3-dimensional digital models of various types of skin wounds. Since the final users will be physicians and not computer experts, a user-friendly system is believed to be a fundamental parameter for its success.

The accuracy of scanning systems has improved in the past few years, and prices have also decreased, making these devices affordable for a wider community of potential users.⁶ The integration into a single system of capabilities that can capture the shape and surface reflection characteristics makes 3-dimensional scanning an invaluable resource in all those applications where it is necessary to sample both surface attributes.

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The Diagnostic Yield of Histopathologic Sampling Techniques in PAN-Associated Cutaneous Ulcers

Polyarteritis nodosa (PAN), a medium-sized vessel (MSV) vasculitis, may result in cutaneous ulcers.¹ There is no specific serologic abnormality associated with PAN; therefore, the mainstay diagnosis consists of histologic evidence of MSV vasculitis in the context of pertinent clinical findings.² Several factors may contribute to the potential low diagnostic yield of tissue biopsy specimens from MSV-vasculitic ulcers. The present study evaluates the role of tissue sampling in the histologic evaluation of PAN-associated cutaneous ulcers.

Methods. Retrospective analysis of de-identified archival biopsy specimens taken from skin ulcers and sural nerves of 29 patients with histologically proven PAN-associated MSV vasculitis. Patients met the classifica-

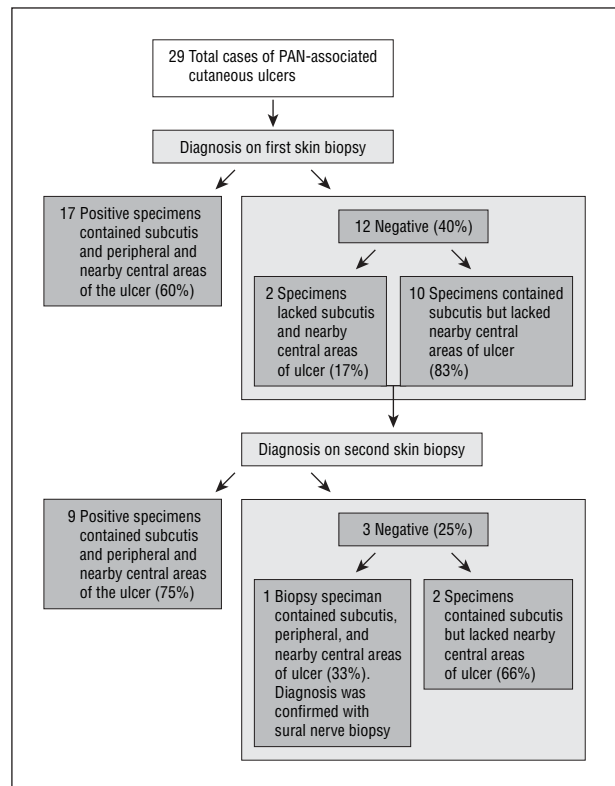


Figure 1. Evaluation of the role of sampling technique and site of polyarteritis nodosa (PAN)-associated cutaneous ulcer in the yield of the histopathologic diagnosis.