EFFECTS OF CAMERA ANGLE ON ACCURACY OF WOUND AREAS DETERMINED BY DIGITAL PLANIMETRY

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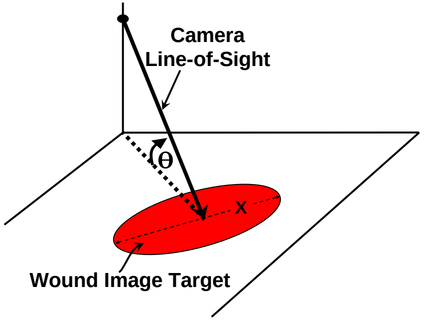
BACKGROUND/GOALS

A useful method to track a wound's progress is to measure its area via planimetry of digitized photographs. However, without care, this method can result in large errors. One potential error source relates to the angle (θ) between the camera's line-of-sight and wound plane. We sought to mathematically and experimentally estimate this area error.

METHODS

Shapes of known area, and wound shapes, were photographed with a digital camera at angles (θ) between 90° and 30° to the plane of the image as illustrated in the figure below. The length of the image (x dimension), as viewed within the LCD of the camera, was maintained constant at each angle by suitably adjusting the camera zoom to provide proper comparison.



Areas were determined by tracing the perimeter of the digitized image using software** designed specifically for computerized planimetry of wounds. Photos included horizontal (x) and vertical (y) calibration scales. Measured areas were compared using one and two-dimensional calibrations and also compared with mathematical predictions of the effect of θ on measured area.

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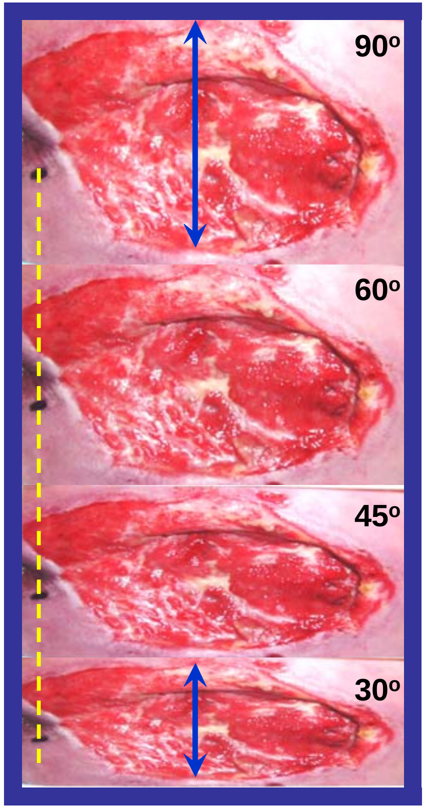
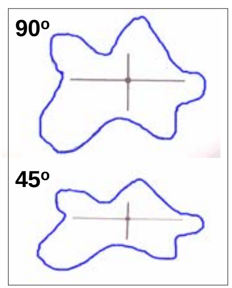
EFECT OF ANGLE ON WOUND SIZE

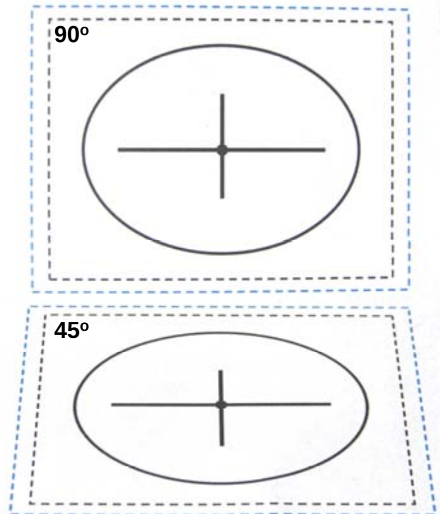


The figure above shows the main angle effect. The "y" dimension appears foreshortened as θ decreases. As might be imagined, this results in a reduced measured area unless the "y" dimension contraction is taken into account.

The adjacent figure is an example of area tracings for a complex venous ulcer shape photographed at 90° and 45°. Area measured at 45° is 0.707 (sinθ) of that measured at 90°. This is exactly as predicted by analysis.

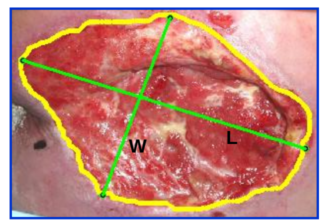


ANGLE RELATED ERRORS



One of the known area shapes used was an ellipse. In the above figures, length and width are 8 and 6 cm. The x and y calibration bars are 6 and 3 cm. Areas measured using only the x calibration vs. using both x and y calibrations, are shown in the result figure.

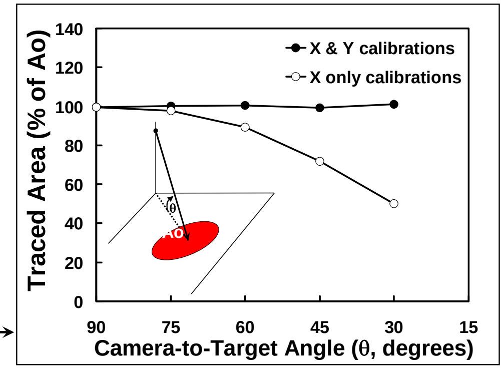
Below right is an example of a wound with the perimeter traced to determine its area. The green lines define length (L) and width (W). All Values (area, L, W, perimeter and shape factor are determined by the software**



Wound with perimeter traced and L and W indicated in green.

RESULTS

Mathematical analysis predicts shortening of the shape's width in proportion to sinθ. For example, in comparison to a photo taken at θ=90° (pointing directly down to the wound), a photo taken at 30° has a projected width that is ½ of the true dimension. This results in an area estimate that is ½ of the actual wound area. The predicted area errors for various angles were confirmed by measurements of various shapes. In the figure below, one of these results is shown for the case of an elliptical shaped wound.



CONCLUSIONS

The intrinsic potential errors described can be overcome in two ways. (1) Take wound photos as close to 90° as possible – this yields no angular area error and a horizontal calibration is sufficient. (2) If this is not possible, and the photographic angle is less than 75°, then calibrating the image in both dimensions will eliminate most of the angular area error. This requires that calibration scales in both directions are included in the wound photograph..