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Development and validation of the tape-to-trace method: An objective outcome measure for linear postoperative scars

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Background/Objectives: Several outcome measures exist for assessing postoperative linear scars, though all have shortcomings. Subjective scales like the Patient and Observer Scar Assessment Scale (POSAS) aggregate scores from various physical scar parameters into an overall score proportional to scar severity. Despite being validated in multiple studies[1], POSAS has been subject to inter- and intra-rater discrepancies due to factors such as observer expertise and scar type, and the surface area has been shown to have a low correlation with overall opinion[2]. As a result, several instruments have been developed to help clinicians measure scar surface area in an objective way. However, these devices are often cumbersome and expensive, and therefore rarely adopted in the clinical setting. Planimetry is a valid and reliable method for assessing wound surface area, but only mathematically accurate for square or rectangular wounds[3]. Computer-assisted planimetry is more accurate but still requires meticulous tracing of the scar onto transparent film and analysis with proprietary computer software[4].

We have devised a simple and inexpensive method of assessing scar surface area called the trace-to-tape method. With this technique, an observer traces a scar with a water-based gel pen applied directly to the skin. The gel residue is then transferred onto clear tape to be scanned into the computer. Using the free image-processing program *ImageJ*, the total scar surface area and mean scar width can be calculated.

Methods: Twenty patients with postoperative scars greater than one month old were recruited from our dermatology clinic. Scars were evaluated by two independent observers using our trace-to-tape method, POSAS, and manual planimetry. We then tested the feasibility and inter- and intra-rater reliability of our trace-to-tape method as well as its validity by comparing it to POSAS and manual planimetry.

Results: Trace-to-tape and manual planimetry methods yielded similarly high intra-rater and inter-rater reliabilities, but the confidence limits for the trace-to-tape method were considerably smaller (Table 1).
Mean scar width and POSAS surface area scores were significantly positively correlated (rho = 0.62 p = 0.003) as were mean scar width and POSAS overall opinion scores (rho = 0.69, p < 0.001) (Figure 1).

Limitations: We were primarily limited by the number of observers and lack of blinding.

Discussion: Having an objective outcome measure for postoperative scars is important for conducting clinical research and

establishing standards of care that maximize patient satisfaction. In our study, we found higher inter-rater reliability with the two objective assessment tools, manual planimetry and the tape-to-trace method, compared to POSAS. While surface area evaluated on POSAS has been shown to have low predictive value for the overall opinion of scars[2], we found that our calculation of mean scar width accurately reflected the cosmetic appearance of scars. Since scar width can vary along the length of the scar[5], our technique of calculating mean scar width from the calculated surface area bypasses the measurement error from measuring scar width at a set point on the scar.

Though manual planimetry was found to be reliable and valid, accuracy depended on scar placement in relation to square grids, and inconsistencies arose when scar margins occupied partial boxes on the grid. The tape-to-trace method circumvented this limitation since it did not rely on a grid system. Manual planimetry was also more cumbersome to perform on curved surfaces such as the face, since it was more difficult to flatten a transparent film over a curved surface.

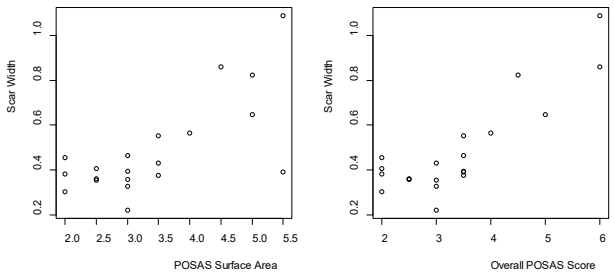
Conclusion: The tape-to-trace method is a reliable objective scar assessment tool that correlates well with POSAS and is more accurate than manual planimetry. This novel method should be considered a practical and affordable option for objective scar assessment in the clinic and research setting.

Table 1: Intra- and inter-rater reliability estimates and 95% confidence limits derived from 5,000 bootstrap samples.

Intra-rater Reliability	**Estimates [95% confidence limits]**
Trace-to-Tape Method	0.95 [0.85, 0.97]
Manual Planimetry	0.94 [0.62, 0.97]
Inter-rater Reliability	
Trace-to-Tape Method (Average)	0.97 [0.87, 0.99]
Manual Planimetry Method (Average)	0.97 [0.66, 0.99]
POSAS Surface Area	0.65 [0.46, 0.81]
POSAS Overall Opinion	0.59 [0.12, 0.81]

Note: Intra-rater reliability was not calculated for POSAS due to likelihood of recall bias.

Figure 1: Relationship between scar width as determined with the trace-to-tape method and POSAS surface area score and POSAS overall opinion score.



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