



Cohort Study

Post-skin incision scar tissue assessment using patient and observer scar assessment scales: A randomised controlled trial

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ABSTRACT

Background: The scalpel was once the gold standard for surgical incisions. Electrosurgery has started to supplant scalpels but is not yet acceptable for skin incisions due to the risk of burns and deeper injury relative to the scalpels' neat incision with less tissue damage. The unnecessary burden of excessive scar formation makes comparing these two methods challenging. Therefore, this study aims to compare post-incision skin scarring created after monopolar electro-surgery and scalpel surgery, and evaluate the Patient and Observer Scar Assessment Scale (POSAS) suitability for assessing skin incision scars by comparing patients' and observers' scores.

Methods: This self-controlled study involved patients undergoing elective and emergency skin surgery procedures. A singular wound site was created using two incision methods (monopolar electro-surgery and scalpel) simultaneously. Post-incision scar tissue formation was evaluated using the POSAS, a subjective scar assessment tool that involved patients self-reporting on pain, itching, color, thickness flexibility, and surface relief. Observer-rated vascularity, pigmentation, thickness, flexibility, and surface relief both using a 5-point Likert-type scale. We performed this assessment three months post-surgery, and the results were analyzed by a battery of statistical tests and linear mixed models.

Results: Twenty patients were included in this study. Data analyzed using the paired *t*-test or Wilcoxon rank-sum test indicated no statistically significant differences between the scar tissue created by monopolar electro-surgery and scalpels according to both the patients and the observers. Correlation analyses between the patients' and observers' total POSAS scores indicated these followed a moderate linear relationship ($r = 0.51$; $p < 0.001$). Linear mixed models further supported the agreement of POSAS total scores between patients and observers. They also confirmed that electro-surgery was not inferior to the scalpel technique.

Conclusion: Scar tissue from skin incisions made by monopolar electro-surgery were indistinguishable from those created with a scalpel. The POSAS instrument is an acceptable means of assessing scar formation on the skin.

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1. Introduction

The scalpel was once the gold standard for surgical incisions [1–3]. Electrosurgery is the application of electric current converted into heat to cut and coagulate tissues. It was invented by William T. Bovie and was first used as an electrosurgical generator by surgeon Harvey Cushing in 1962 [4]. Although such technology has since largely replaced scalpels, it is not acceptable for skin incisions because of the risk of burns and deeper injury [5,6]. The fear of burns resulting in scar tissue formation prevents them from being compared with scalpels, which provide a neat incision with less tissue damage [7].

Many studies have compared the use of electrosurgical methods with scalpels; for example, Peterson (1982) in cosmetic and reconstructive maxillofacial surgery and Tobin (1985) in blepharoplasty both found that incisions made using electrosurgery resulted in lesser post-operative pain with minimal bleeding and scarring compared to scalpel incisions [8,9].

Scar tissue has many far-reaching effects. For example, facial scarring impacts psychosocial function, and scar tissue due to burns affect physical dysfunction [10]. Several modalities have been used to assess scar tissue to predict and evaluate response to treatment. These include both objective and subjective assessments [10–12]. The Patient and Observer Scar Assessment Scale (POSAS) is a subjective scar assessment instrument consisting of a self-reported score from the patient that includes pain, itching, color, thickness flexibility, and surface relief of scar tissue and also an observer's score that includes vascularity, pigmentation, thickness, flexibility, surface relief as well as the surface area of scar tissue [13–15]. The POSAS has been applied to evaluate various operative scars and preexisting scars such as post-operative scars, burn or traumatic scars and hypertrophic scars [9,10].

This study aims to compare post-incision scarring from monopolar electrosurgery and that from surgery using a scalpel and determine whether the POSAS is a suitable tool for assessing these skin incision scars.

2. Materials & methods

2.1. Study design

This self-controlled trial study included 20 patients, each of whom underwent a single surgery in which two incision methods were employed simultaneously: monopolar electrosurgery and scalpel surgery. We treated the entire skin area subjected to both incision methods according to standard procedures before and after the surgery. Post-incision scar tissue formation was assessed simultaneously by an observer and the patient three months after the operation was carried out at Prof. Dr. R. D. Kandou General Hospital Manado. Our Institutional Review Board approved this research (Protocol number: 135/EC/KEPK-KANDOU/XII/2020) and has been registered with the research registry no. 7192. We obtained written informed consent from all of the participants. We carried out the work in line with the Consolidated Standards of Reporting Trials (CONSORT) [16].

2.2. Population and sample

The subjects in this study met all of the following inclusion criteria. Patients aged 18–70 years with elective or emergency surgery involving clean or clean-contaminated wounds, a surgery that does not involve the neck, face, or other parts of the head, and no history of keloids. Those who met these inclusion requirements were excluded from the list of prospective samples if they had contaminated or dirty wounds or a history (personal or family) of conditions or diseases that can affect wound healing [17].

2.3. Measures

The main research instrument was the POSAS [13–15], which both observers and patients completed. Twenty patients and three observers were given a set of questions to answer, giving a subjective opinion of the scars. On our 20 subjects, either vertical or horizontal incisions were made on the lower extremity, trunk, breast and abdominal areas with incision sizes ranging from 130 mm to 250 mm. We collected baseline data such as wound shape and size from each patient. Each incision site was marked, wherein half (proximal/medial) was to be incised with a scalpel, and the remaining half (distal/lateral) was to be incised with ValleyLab™ FT10 (Medtronic, USA). The surgery and incision results were documented (Fig. 1A). Assessment of the scar tissue at the incision was then performed at the three-month follow-up appointment (Fig. 1B).

2.4. Statistical analysis

A descriptive analysis of the distribution of the investigated variables was carried out using univariate and bivariate methods. The univariate analysis included an assessment of the distribution of each variable, including the normality of the numerical variables. This evaluation was carried out using graphs such as histograms, boxplots, and density curves in addition to the Shapiro-Wilk's normality test. For categorical variables, distribution assessments were carried out through frequency tables. The concentration and dispersion values were calculated according to the type of variable and the normality of the distribution for the numerical ones. For normally distributed numerical variables, values are presented as means with their standard deviation (SD). In cases of abnormal distribution, the median value and interquartile range (IQR) are given. For categorical variables, the proportion value is shown for each of them. Differences in patient characteristics according to sex were assigned and tested using the *t*-test on numerical variables and Fisher's exact method for categorical variables.

Comparison of the quality of scar tissue resulting after monopolar electrosurgery and scalpel surgery was performed using the paired *t*-test or the Wilcoxon rank-sum test for numerical variables and the Friedman test for categorical variables. The choice of procedure for this paired data was based on a study design in which the two-incision methods were performed simultaneously on each subject. The degree of similarity

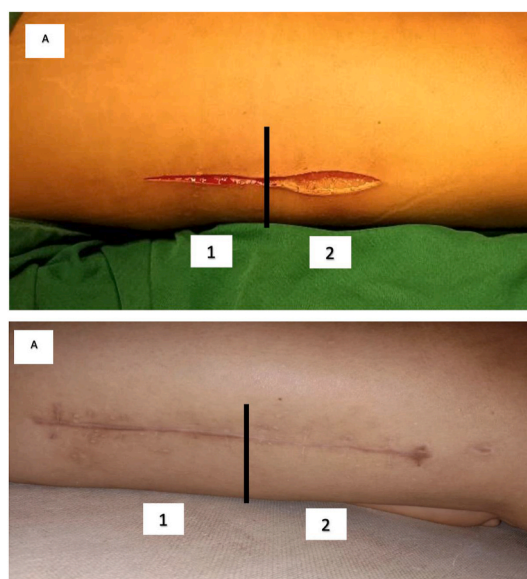


Fig. 1. (A) Comparison of a scalpel incision (1) and monopolar electrosurgery (2); (B) Comparison of the quality of scar tissue from a scalpel (1) and monopolar electrosurgery (2).

between the patients' and observers' assessment of scar tissue using the POSAS was determined by calculating Pearson's correlation coefficients. Regression modelling identified any factors associated with the POSAS score, both alone (patient or observer) and combined (patient and observer). A linear mixed model with random intercept analysis was conducted at the univariate and multivariate levels. The regression analysis results are presented as the estimated values for the regression parameters and the 95% confidence intervals, as well as the p-values. The R statistical software package version 4.0.1 was used for data processing and statistical analysis [18,19].

3. Results

3.1. Patient characteristics

Twenty patients participated in the study. The majority (n = 12; 60%) were female (Table 1). The mean age of the patients was 50 years (SD 16.3 years). The mean age of the male patients was younger than their female counterparts; however, this difference was not statistically significant (44.4 vs 54.1 years; p > 0.05). The incision size in female patients was approximately 26 mm longer than in male patients; however, this difference was again non-significant. The majority of the wound incisions were vertical, and only 8 (40%) were horizontal, all of which were on female patients.

3.2. Scar assessment using the POSAS

Table 2 presents the results of the post-skin incision scar tissue assessment using the POSAS recorded by the patients and the researchers. In addition to the scores for each scale, Table 2 also shows the patient and observer scores combined. The p-values relate to the comparison between the scar tissue formed after monopolar electro-surgery vs scalpel surgery.

In the patients' assessment, the median value for each component ranged from 2 to 4 and did not differ significantly according to the incision method (monopolar electro-surgery vs scalpel surgery). The median total patient-scale POSAS score was approximately 21–22 for both techniques, which translates into a mean of 3.5–3.7 for each of the six components. The largest proportion of patients, around 50%, scored in the 19–24 category (medium score) on the POSAS. On average, the itching scores were the lowest (2.0), while the scores for stiffness and thickness were the highest (both at 4.0).

In the observer's assessment, the median value for each POSAS component ranged from 2 to 3. However, in contrast to the patients, the observers' scores on the vascular component were significantly different for the electro-surgery and scalpel methods (p = 0.048). For these components, the median difference was around 0.5, with the scalpel technique scoring slightly worse. The median total POSAS score on the observer side was around 16. The largest proportion for the two surgical techniques was in the under 18 categories (low score). The difference in the total POSAS score on the observer scale was not significant at the 0.05 level.

Table 1
Patient characteristics.

	Total (N = 20)		Male (n = 8)		Female (n = 12)		p ^a
	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Age (years)	50.2	16.3	44.4	19.2	54.1	13.6	0.200
Incision Size (mm)	190.5	58.7	175.0	65.5	200.8	54.2	0.349
Incision Shape, n (%)							
Horizontal	8	40	0	0	8	67	0.005
Vertical	12	60	8	100	4	33	

NOTES: SD standard deviation. ^a t-test results for numerical variables and Fisher's exact test for categorical variables.

Correlation analysis indicated a moderate linear relationship between the total POSAS scores reported by the patients and the observers (r = 0.51; p < 0.001) (Fig. 2). Fig. 2 also contains the correlation scores for each patient and observer with the total score from the sum of the two rating scales.

3.3. Linear regression analysis

Table 3 shows the results of the regression analysis using the random intercept model. This was carried out with the total POSAS scores from both groups separately and combined as the outcome. Incision technique (electrosurgery vs scalpel) and rater (observer vs patient) were the main predictors in a multivariable model controlled for variations in age, sex, and the shape and size of the incision. In all models, the incision technique did not significantly relate to the outcome, namely the total POSAS score. This applies to both the POSAS scores of the patients, observers, and both combined. Excluding the incision method, age appeared to influence both the patients' total POSAS score (p = 0.002) and the combined score (p = 0.026). Each increase in age was associated with a decrease in the total POSAS score by 0.2–0.3 points from this analysis. As with the incision method, neither the sex of the patient nor the shape and size of the incision were significantly correlated to the total POSAS score.

4. Discussion

The fear of burning scar tissue caused by the heat generated from monopolar electro-surgery has spurred comparisons with scalpels, which provide a neat incision with less tissue damage [7,20,21]. The pathophysiological theory of scar tissue underlies these concerns by positing that the additional tissue damage associated with monopolar electro-surgery prolongs the inflammatory phase, one of the causes of hypertrophic scarring [22–24]. However, with good knowledge and proper technique, injury to both sides of the incision can be minimized [25].

This study was based on 20 surgical wounds categorized as either surgery with clean wounds or clean-contaminated wounds.

Therefore, POSAS scores from patients, researchers, or the combination did not differ significantly according to the incision method (monopolar electro-surgery vs scalpel). Only the observers recorded significantly different scores for the monopolar electro-surgery and scalpel methods but only for the vascular component (p = 0.048). The median difference between these components was around 0.5, i.e., the scalpel technique scored slightly worse. Correlation analysis on the total POSAS scores from the patients' and observers' assessments exhibited a moderate linear relationship (r = 0.51; p < 0.001) (Fig. 2). This is sufficient to establish similarity between the independent POSAS ratings. The results of the regression analysis showed that age seemed to affect the total POSAS score from the patients (p = 0.002) and both groups combined (p = 0.026). Each increase in age tended to decrease the total POSAS score by 0.2–0.3 points for both. This association is likely mediated by hormone levels and skin tension, both of which decrease with age.

Many factors affect scar tissue formation after electro-surgery [26, 27], including the type of active tip used with the electrode, the amount of power, incision speed, and surgery type, in addition to the patient's age, genetics, and comorbidities. The smaller the active tip of the electrode, the more concentrated the electric flow, resulting in a faster tissue-cutting effect. On the other hand, a wider active electrode tip causes less focused electric flow, so tissue cleavage occurs more slowly, and more heat is transmitted to the surrounding tissue. As power and incision speed increase, so does heat build-up; therefore, these must be carefully chosen and closely monitored to minimize heat-related tissue damage [25,27].

Tobin (1985) studied blepharoplasty surgery using monopolar electro-surgery with a needle tip and a power scale starting from 1 W. He found that electrodes with smaller tips and low electric flow minimize

Table 2
Post-incision scar tissue quality according to incision technique using the POSAS.

Characteristics	Total (N = 40 ^a)		Electrocautery (n = 20)		Scalpel (n = 20)		p ^b
	n (%),or Mean (SD)	Median (Q ₁ – Q ₃)	n (%),or Mean (SD)	Median (Q ₁ – Q ₃)	n (%),or Mean (SD)	Median (Q ₁ – Q ₃)	
POSAS Patient Scales							
Pain	*	3.0 (2.0–4.0)	*	3.0 (2.0–4.2)	*	3.5 (2.0–4.0)	1.000
Itch	*	2.0 (1.0–3.0)	*	2.0 (1.0–3.0)	*	2.0 (1.0–3.0)	0.180
Color	*	4.0 (3.8–5.0)	*	4.0 (3.8–5.0)	*	4.0 (3.8–5.0)	0.527
Stiffness	*	4.0 (3.0–5.0)	*	4.0 (3.0–5.0)	*	4.0 (3.0–5.0)	0.763
Thickness	3.8 (1.5)	*	4.0 (1.5)	*	3.8 (1.4)	*	0.214
Relief	*	3.0 (3.0–4.0)	*	3.0 (3.0–4.0)	*	3.0 (3.0–4.0)	0.160
Total score	21.5 (5.0)	*	21.8 (5.4)	*	21.2 (4.7)	*	0.473
≤18	10 (25)	*	5 (25)	*	5 (25)	*	0.655
19–24	19 (48)	*	10 (50)	*	9 (45)	*	
>24	11 (28)	*	5 (25)	*	6 (30)	*	
POSAS Observer Scales							
Vascularity	*	2.0 (2.0–3.0)	*	2.0 (2.0–3.0)	*	2.5 (2.0–3.0)	0.048
Pigmentation	*	3.0 (2.0–3.2)	*	3.0 (2.0–4.0)	*	3.0 (2.8–3.0)	0.705
Pliability	*	3.0 (2.0–3.0)	*	2.5 (2.0–3.0)	*	3.0 (2.0–3.0)	0.414
Thickness	*	2.0 (2.0–3.0)	*	2.5 (2.0–3.0)	*	2.0 (2.0–3.0)	1.000
Relief	*	3.0 (2.0–3.0)	*	3.0 (2.0–3.0)	*	3.0 (2.0–3.0)	0.480
Surface area	*	3.0 (2.0–3.0)	*	3.0 (2.0–3.2)	*	3.0 (2.8–3.0)	1.000
Total score	*	16.0 (14.0–18.6)	*	16.0 (14.0–17.0)	*	16.5 (13.8–19.0)	0.615
≤18	29 (72)	*	17 (85)	*	12 (60)	*	0.127
19–24	9 (22)	*	2 (10)	*	7 (35)	*	
>24	2 (5)	*	1 (5)	*	1 (5)	*	
POSAS Patient & Observer Scales							
Total score	*	36.0 (33.0–42.2)	*	36.0 (34.8–40.8)	*	36.5 (32.8–42.5)	0.537

NOTES: SD standard deviation, Q₁ Quartile I. Q₃ Quartile III. POSAS Patient and Observer Scar Assessment Scale.

^a Both techniques were used on the 20 subjects at the same time, generating a total of 40 samples.

^b Paired t-test or Wilcoxon rank-sum test results for numerical variables. χ^2 Friedman test for categorical variables.

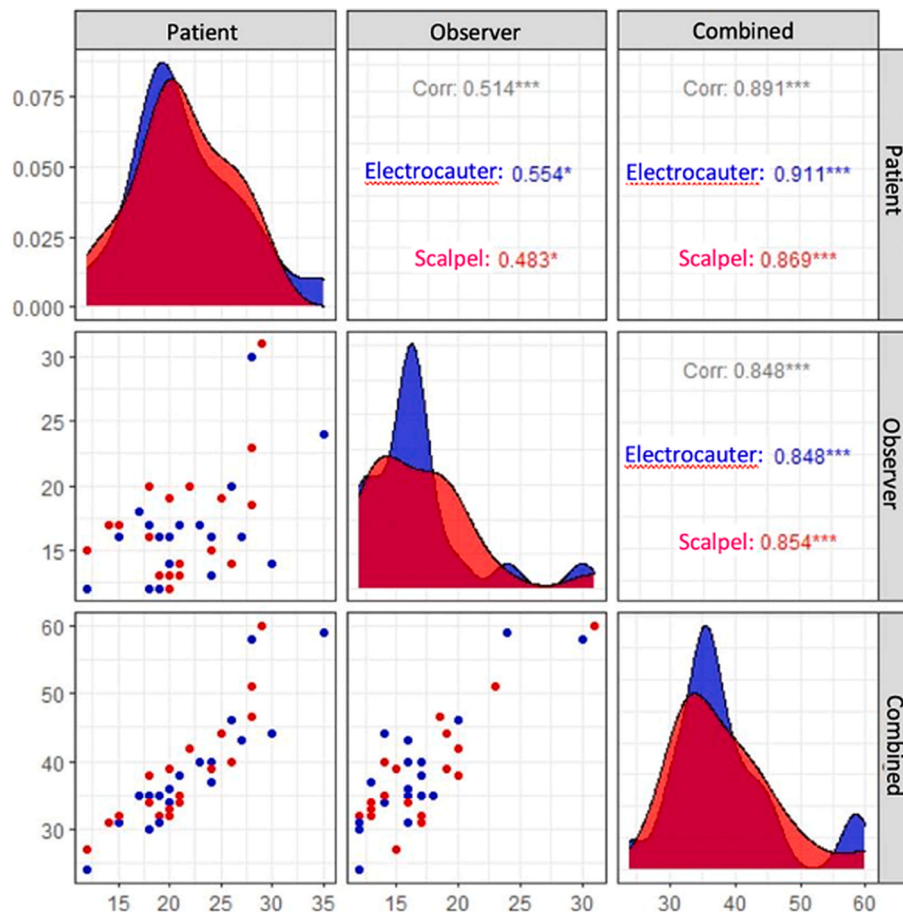


Fig. 2. Correlation Matrix Scale of POSAS Scores from Patients, Observers, and Both Combined According to Incision Technique. Numbers on the matrix are Pearson's correlation coefficient values.

Table 3

Linear mixed model with random intercept analysis post-incision scar tissue assessment using the POSAS.

Variable	Regression Model Outcome ^a			
	POSAS Patient		POSAS Observer	POSAS Combined
	β (95% CI)	<i>p</i>	β (95% CI) <i>p</i>	β (95% CI) <i>p</i>
Technique: Scalpel vs Electrocautery	-0.50 (-1.93; 0.93)	0.473	0.47 (-0.97; 1.92) 0.499	-0.03 (-2.27; 2.22) 0.982
Age	-0.22 (-0.34; -0.10)	0.002	-0.05 (-0.19; 0.09) 0.443	-0.27 (-0.50; -0.04) 0.026
Sex: Female vs Male	2.15 (-3.01; 7.31)	0.389	3.48 (-2.22; 9.18) 0.213	5.63 (-4.08; 15.34) 0.236
Incision Shape: Vertical vs Horizontal	-0.36 (-6.01; 5.29)	0.894	1.97 (-4.28; 8.21) 0.512	1.61 (-9.03; 12.24) 0.752
Incision Size	0.00 (-0.04; 0.03)	0.916	0.00 (-0.04; 0.04) 0.951	0.00 (-0.07; 0.07) 0.984

NOTES: CI confidence interval, POSAS patient and observer scar assessment scales.

^a All models were tested in a multivariable regression model.

the heat formed at the point of contact between the electrode tip and the tissue. The results of his research suggest that incisions performed using electrocautery result in minimal scarring [7].

Kearns et al. (2001) reported that the use of electrodes that drain sinusoidal flow could cause tissue to split without damaging the surrounding tissue because the heat generated is dissipated as vapor rather than transmitted to the surrounding tissue. They used a standard type (blade) active electrode in cutting mode to make a midline laparotomy skin incision and found no significant difference in postoperative wound complications between electrocautery and scalpels. Other advantages of using monopolar electrocautery include faster incision time, less bleeding, and reduced postoperative pain [7,28].

Kalawar et al. (2015) compared scar tissue formation after skin incisions made using monopolar electrocautery and scalpels in closed-fracture surgery with implant placement, using a standard type (blade) active electrode in cutting mode at 5 W. The monopolar electrocautery skin incisions were performed at an average rate of 1.8 mm/s. They found no significant difference in wound healing (scar tissue formation and postoperative pain) between monopolar electrocautery and scalpel surgery after 3 months. Moreover, electrocautery is associated with a shorter incision time [29].

In our research, the active electrode used was the blade type with a 20-W scale set to pure cut mode. Incisions were made at a rate of 3–5 cm/s in a variety of types of surgery. Our results indicate that there was no significant difference in the formation of scar tissue or pain and itching associated with the skin incision method (monopolar electrocautery or scalpel) 3 months after the surgery.

Our research and previous studies show that scar tissue formation varies according to electrocautery instrument, technique, and surgery type. However, in agreement with previous studies, we found no significant difference in scar tissue formation for skin incisions made using monopolar electrocautery and scalpels.

Based on the paired *t*-test or Wilcoxon rank-sum test, the scar tissue rating scores from patients and researchers (or a combination thereof) did not vary significantly according to the incision method (monopolar electrocautery and scalpels). Rather, the POSAS scores from the patients and observers displayed a moderate linear relationship ($r = 0.51$; $p < 0.001$) in correlation tests.

5. Conclusions

The use of monopolar electrocautery and scalpels to make skin incisions resulted in similar scar tissue formation. The POSAS instrument is suitable for assessing scar tissue, given the agreement between the scorers reported by patients and researchers.

Ethical approval

All procedure for human experiment has been approved by Ethics Commission of Kandou Hospital Manado, Number: 135/EC-KEPK/XII/2020.

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Author contribution

Mendy Hatibie Oley, Maximillian Christian Oley, Christian Manginstar, David Barends, Fima Lanra Fredrik G. Langi, and Deanette Michelle R. Aling initiated and designed the study.

Fima Lanra Fredrik G. Langi performed the statistical analysis.

Billy Johnson Kepel, Rangga Rawung, Angelica Maurene Joicetine Wagiu, and Muhammad Faruk contributed in the data processing.

All authors have read and approved the final manuscript.

Trial registry number

This study has been registered with the Research Registry no. 7192.

Guarantor

Mendy Hatibie Oley and Maximillian Christian Oley.

Consent

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The patients have given their written informed consent on admission to use their prospective data base and files for research work.

Provenance and peer review

Not commissioned, externally peer reviewed.

Declaration of competing interest

The authors declare that they have no conflict of interests.

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