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Comparison of Colorado Needle Electrocautery and Traditional Scalpel for Lower Eyelid Blepharoplasty Incision: A Randomized Controlled Trial

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Background: Lower eyelid blepharoplasty is one of the most popular aesthetic procedures. Electrocautery provides a hemostatic benefit for skin incision; however, its effect on scar cosmesis remains unclear, particularly in Asian skin types. We compared the Colorado needle electrocautery (pure-cutting mode) versus the traditional scalpel in terms of efficacy, complications, and cosmetic outcomes.
Methods: A prospective intraindividual randomized controlled trial was conducted to compare the efficacy of Colorado needle electrocautery and scalpel in lower blepharoplasty. The study outcomes were scar quality at different times until 1 year postoperatively, bleeding during incision, and postoperative ecchymosis. Scar quality was evaluated using 3 standard scar ratings: the Vancouver Scar Scale, Patient and Observer Scar Assessment Scale, and Hollander wound evaluation scale.
Results: The study included 25 patients, and the electrocautery side had less blood loss during incision than the scalpel side (2.6 ± 0.65 versus 5.28 ± 0.68 sticks; $P < 0.001$). The electrocautery side had less postoperative ecchymosis ($P < 0.001$); however, 1-year scar quality was not statistically significant between the groups.
Conclusions: Colorado needle electrocautery pure-cutting mode can be an alternative to the traditional scalpel for lower eyelid blepharoplasty skin incision because of long-term scar quality. Electrocautery also has hemostatic benefits, leading to a decrease in intraoperative and postoperative bleeding. *(Plast Reconstr Surg Glob Open 2024; 12:e6325; doi: 10.1097/GOX.0000000000006325; Published online 22 November 2024.)*

INTRODUCTION

Lower eyelid blepharoplasty is one of the most popular aesthetic procedures worldwide, being the third most common worldwide according to the International Society of Aesthetic Plastic Surgery report in 2022.[1] It is the most popular aesthetic surgical procedure in Thailand, accounting for 22,363 of 170,664 aesthetic surgical procedures in 2022.[2] The goal of lower eyelid blepharoplasty is to rejuvenate the lower eyelid while maintaining a natural, unoperated appearance. Successful lower eyelid blepharoplasty depends on anatomical knowledge and surgical techniques, accurate preoperative analysis, and attention to detail. Functional and cosmetic improvement are indicators of a successful blepharoplasty procedure and patient satisfaction.[3,4] Careful patient evaluation, proper selection of the procedure, precise operative technique, and appropriate postoperative care can affect these functional and cosmetic outcomes. Lower eyelid blepharoplasty has a lengthy operative sequence, with lower eyelid incision greatly influencing outcomes.[5,6] Many devices can be used for lower eyelid blepharoplasty incision, including scalpel, electrocautery, and laser.[7,8] However, surgeons still seek the best device that can achieve the goal of skin incision; particularly, it should have easy handling, easy incision with little pressure, tissue stretching and minimizing slant, good hemostasis during incision, less lateral tissue damage, less scar formation, and faster sensory recovery. The scalpel is a traditional device with fast healing time, fewer scars, and almost no lateral tissue damage,[9] but it does not provide hemostasis, which can cause difficulty in

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visualization during incision. It also has issues with pressure; the scalpel requires skin stretching and handheld pressure during incision, which can cause problems in complicated cases, particularly in older patients with a fragile outer skin layer, thin and translucent epidermis, minimal dermis, and poor-quality fat with weakened tissue support.[10,11]

In a previous study[12] of upper blepharoplasty incision, using electrocautery (cutting mode) for skin incision had a benefit in postoperative bleeding but no clinically significant difference in scar quality and outcome when compared with scalpel.

In cutting mode, the electrode touches the tissue, and high-power density vaporizes its water content, forming a nonconductive vapor layer. If the voltage is high enough (>±200 V), the vapor ionizes into a conductive plasma, ejecting tissue fragments and creating a crater. Cutting electrodes often have a fine wire or loop. In coagulation mode, lower power is used, generating heat that coagulates the tissue without causing explosive vaporization or craters, effectively stopping bleeding.[13]

This randomized controlled trial (RCT) aimed to compare Colorado needle electrocautery (pure-cutting mode) and traditional scalpel to determine their efficacy and cosmetic outcomes in lower blepharoplasty incision. We studied both patient and physician views using the Vancouver Scar Scale (VSS),[14,15] Patient and Observer Scar Assessment Scale (POSAS),[16,17] and Hollander wound evaluation scale.[18,19] Our primary objective was to compare the efficacy and cosmetic outcomes of the 2 methods, whereas our secondary objective was to compare the results of our study with those in the existing literature.

Takeaways

Question: Does using a Colorado needle for skin incision provide any advantages in terms of operative time, postoperative outcomes, and scar quality?

Findings: The Colorado needle reduces operative time by speeding up the skin excision process and also decreases postoperative ecchymosis. However, there is no difference in long-term scar outcomes.

Meaning: The Colorado needle is a viable alternative for skin incisions in lower eyelid blepharoplasty.

MATERIALS AND METHODS

This prospective RCT was conducted from 2021 to 2023, and subjects were enrolled from June 2021 to October 2022. This study was approved by the institutional review board of the Royal Thai Army Medical Department and the ethics committee. This study was conducted at Phramongkutklao Hospital, a tertiary care hospital in Bangkok, Thailand, between June 2021 and October 2022. The study protocol was registered with the institutional review board of the Royal Thai Army Medical Department (IRBRTA 823/2564, Code R002h/64). All participants

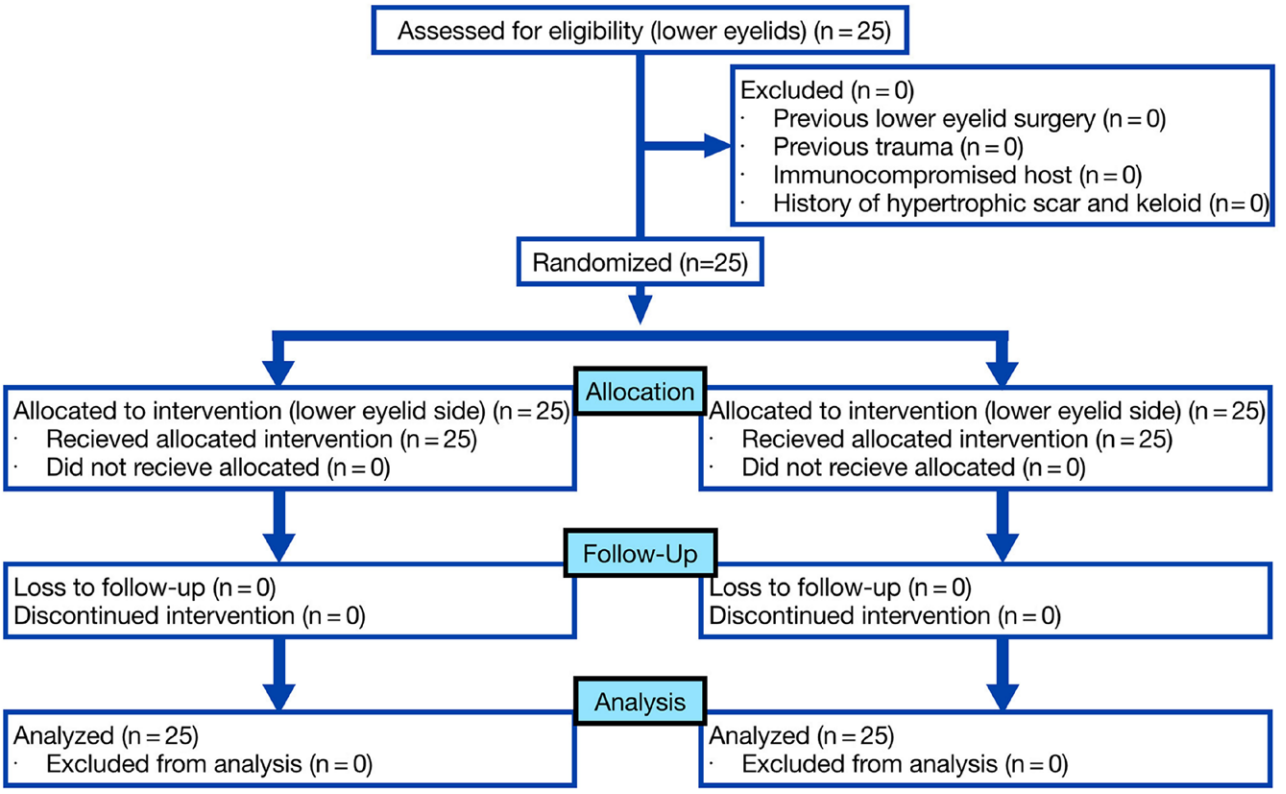

Fig. 1. Consolidated standards of reporting trials flow diagram.

provided written informed consent for the publication of their photographs.

Participants were subject to the following inclusion criteria: age 60–85 years, planning to undergo lower blepharoplasty, and American Society of Anesthesiologists Classification I. The exclusion criteria included the following: previous lower blepharoplasty procedure, allergy to anesthetic agent, immunocompromised host, underlying bleeding disorder, current use of antiplatelet or anticoagulant therapy, and history of hypertrophic scar and keloid. Preoperative photographs were taken, and demographic data were recorded. Sample sizes were calculated before the study participants were enrolled using the clinical superiority design formula using G*power program.[20]

Randomization

The incision of the lower blepharoplasty was divided into left and right sides; one side used Colorado electrocauterization (study group), whereas the other used scalpel no. 15 (control group). Stratified block randomization was performed to determine which side to operate on first. The randomization sequence was computer generated and stratified according to our center. The blocks were varied between 4 and 6 to prevent deciphering. Sequentially numbered, opaque, sealed envelopes were used. The sequence was generated by an independent statistician. Cardboard was inserted into each envelope to make it impermeable to light. Randomization was performed in the operating room. Before the start of the operation, the first assistant requested the sequence number from the central center. After obtaining the code from the central center, the first assistant informed the surgeon to start the operation.

Procedure Preparation

The surgical site was prepared under sterile conditions. The operation was performed under local anesthesia, 1% Xylocaine with local injection of adrenaline into each site 5–7 minutes before incision to that site. For electrocautery incision, we used Valleylab force Fx, Heat level 8–15 with[21,22] the Colorado needle electrocautery device.[23,24] On the other site, the traditional surgical scalpel no. 15 was used. Surgery was performed using standard lower eyelid surgical methods with a full-incision technique. The skin was removed according to the preoperative marking plan, followed by excision of the orbicularis muscle strip to access the pretarsal space and remove excess fat. Blepharoplasty was performed by six senior surgeons at the Plastic and Reconstructive Surgery Department, Phramongkutklao Hospital. (**See Video [online]**, which demonstrates the incision method.)

Outcome Measurement

Intraoperative data were recorded, including incisional time (from the start of incised skin until all skins were extracted or until reaching the terminal edge of the incisional line in patients who did not need eyelid skin extraction) and intraoperative bleeding during skin incision. Follow-up was performed on day 3, day 7, and 1 month postoperatively to evaluate the ecchymosis area (cm^2) using the Wound Doc application (Dalian Orientech Company, Liaoning, China). Patients also had appointments at 1 month, 3 months, 6 months, and 1 year postoperatively for scar evaluation using the VSS, POSAS, and Hollander wound evaluation scale. Complications, including hematoma, surgical site infection, asymmetry, proptosis, ectropion, and entropion, were recorded.

Statistical Analyses

Statistical analyses were performed using STATA/SE 15.1. For comparative statistics, the paired *t* test was used. Repeated analysis of variance was used for comparative statistical analysis of ecchymosis, POSAS, and the VSS. The Hollander wound evaluation scale was analyzed using the McNemar test. The Fisher exact test was used to analyze groups of dichotomous variables (eg, hypopigmented and hyperpigmented scars). A difference of a *P* value less than 0.05 was considered statistically significant.

RESULTS

This study included 25 patients, and no patient was excluded. All patients remained until the end of the study, and none were lost to follow-up (Fig. 1). The average patient age was 66.1 years (range, 60–82 y), including 19 women (76%) and 6 men 6 (24%). The mean weight, height, and body mass index were 62.4 ± 10.3 kg, 163.8 ± 7.32 cm, and 23.14 ± 2.12 kg/m^2, respectively. The underlying disease and anticoagulant status were recorded and reported in Table 1.

Table 1. Demographic Data (n = 25)

Variables	Statistics Data
Sex	
Women	19 (76%)
Men	6 (24%)
Age (y)	66.08 ± 5.87
Weight (kg)	62.4 ± 10.3
Height (cm)	163.84 ± 7.32
BMI (kg/m^2)	23.14 ± 2.12
Operation	
Lower blepharoplasty alone	25 (100%)
Underlying disease	14 (56%)
Hypertension	13 (52%)
Diabetes mellitus	5 (20%)
Dyslipidemias	2 (8%)
Surgeon hand dominant, right	25 (100%)
Electrocautery	
Left	13 (52%)
Right	12 (48%)
Scalpel	
Left	12 (48%)
Right	13 (52%)
To do first	
Left	12 (48%)
Right	13 (52%)

Table 2. Intraoperative Data

	Electrocautery	Scalpel	*P*
Time of skin extraction (s)	171.74 ± 53.49	185.74 ± 65.5	0.115
Bleeding (mL)	1.3 ± 0.32	2.64 ± 0.34	<0.001*

Paired *t* test.
*Indicates statistical significance.

The average skin extraction time was not significantly different between the electrocautery side and scalpel side (171.74 ± 53.49 versus 185.74 ± 65.5 s) (Table 2; Fig. 2). Bleeding during skin extraction, measured by the number of cotton swab sticks, was significantly less in the electrocautery side (average of 2.6 ± 0.65 versus 5.28 ± 0.68 sticks; $P < 0.001$) (Figs. 3, 4). The area of ecchymosis was estimated for eyelid skin incision on days 3, 7, and 30, respectively; these were 5.1 ± 2.27, 3.44 ± 2.5, and 0 cm^2 on the electrocautery side and 6.77 ± 3.17, 4.94 ± 3.47, and 0 cm^2 on the scalpel side ($P < 0.001$) (Table 3; Figs. 5, 6). (**See figure, Supplement Digital Content 1**, which displays an example case: ecchymosis at 3 days [above], 7 days [middle], and 30 days [lower] postoperatively; right lower eyelid: electrocautery, left lower eyelid: scalpel. **http://links.lww.com/PRSGO/D650**.)

We recorded the changes in postoperative wound and scar measurements at 1 month, 3 months, 6 months, and 1 year using the VSS, POSAS, and Hollander wound evaluation scale. The outcomes regarding pigmentation demonstrated no significant difference. At 1 month postoperatively, hypopigmentation was noted in 2 people (8%) on the electrocautery side and scalpel side. At 3 months, this was noted in 1 person (4%) on the electrocautery side and none on the scalpel side. At 6 months, no hypopigmented scars were observed on either side (Fig. 7). Regarding hyperpigmented scars, these were seen in 4 people (16%) on the electrocautery side and none on the scalpel side at 1 month. At 3 and 6 months, there were no hyperpigmented scars on both electrocautery and scalpel sides (Fig. 8). All hypopigmented and hyperpigmented scars disappeared at 1-year postoperative follow-up (Fig. 9). Some scars were itchy in the early months equally on both scalpel and electrocautery sides. No vascularity, pliability, or thickness changes were observed. Using the Hollander wound evaluation scale for scar evaluation, no step-off borders, contour irregularity, margin separation edge inversion, or excessive distortion were found in delicate scars, such as lower blepharoplasty scars. This scale can detect overall appearance distress in the early months, equally on both sides. No complications such as hematoma, surgical site infection, asymmetry, proptosis, ectropion, or entropion were observed.

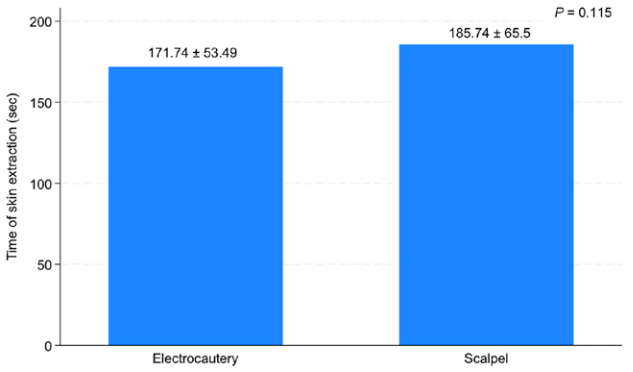

Fig. 2. Time of skin extraction(s).

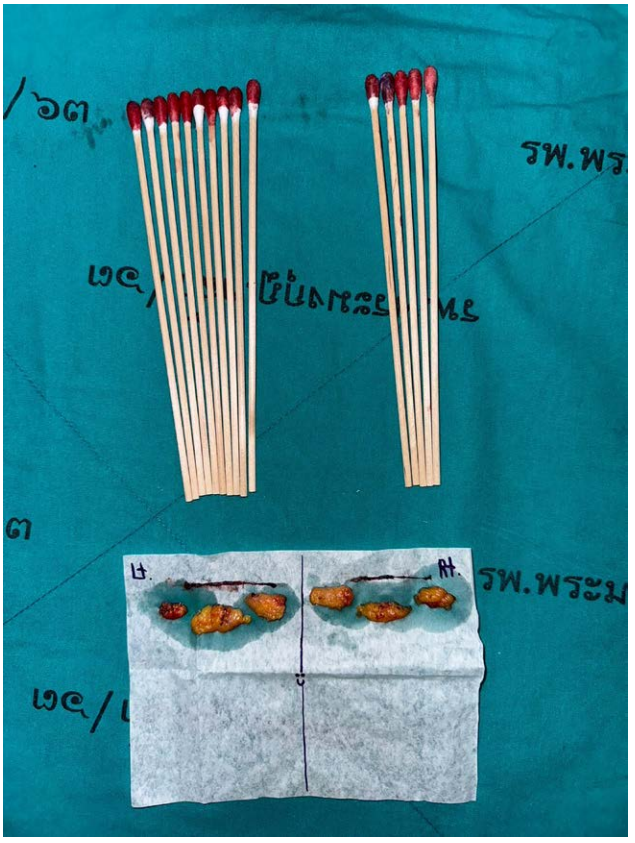

Fig. 3. Cotton bud sticks used for absorbing bleeding and excess skin of the lower eyelid.

DISCUSSION

Electrocautery devices are used to achieve hemostasis while incising through the skin without tissue pressure or stretching. Most surgeons are familiar with the use of electrocautery in almost all procedures. The modes of electrocautery are divided into pure-cutting mode, coagulation mode, desiccation, and fulguration/spray.[25] The cutting mode is commonly used by surgeons for skin incision. Pure-cutting mode electrocautery is characterized by its low voltage and high frequency, which release an electric current in a continuous pattern/sinusoidal wave form, quickly generating high heat that leads to

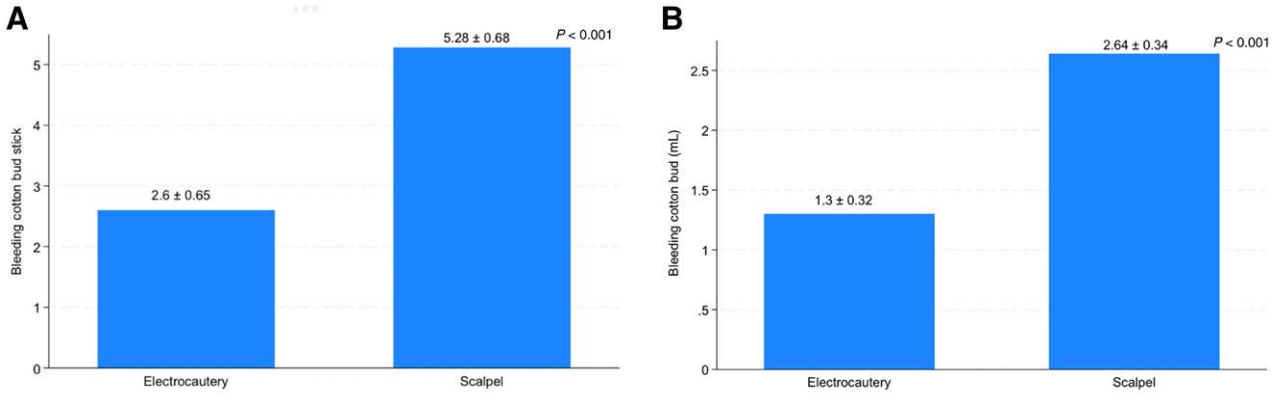

Fig. 4. Intraoperative bleeding during skin incision. A, Number of cotton buds used for absorbing bleeding in each surgical field. B, Volume of bleeding in each surgical field.

Table 3. Ecchymosis

Ecchymosis (cm^2)	Electrocautery	Scalpel	Mean Difference (95% CI)	*P*
Day 3	5.1 ± 2.27	6.77 ± 3.17	−1.67 (−2.27 to −1.08)	<0001*
Day 7	3.44 ± 2.5	4.94 ± 3.47	−1.49 (−2.13 to −0.86)	<0001*
Day 30	0 ± 0	0 ± 0	0	NA

Repeated analysis of variance test.
*Indicates statistical significance.

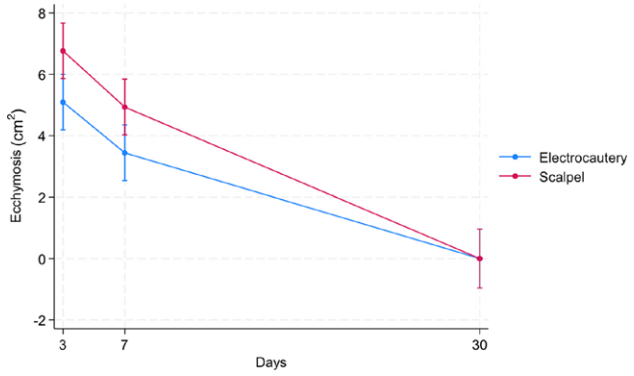

Fig. 5. Area of ecchymosis (cm^3) at 3, 7, and 30 days postoperatively.

tissue vaporization. Steam generated during this process destroys tissue cells to create a cutting effect. The thermal spread is minimal if the active electrode is held just above the target tissue and kept in a constant controlled motion.[26] Because cutting mode electrocautery does not cause desiccation and fulguration, it does not lead to widespread tissue necrosis (seen in coagulation mode), making it ideal to incise the skin. However, some surgeons still question the scar effect of electrocautery.

Our previous systematic review on upper blepharoplasty[12] revealed 5 previous studies on Colorado needle electrocautery in upper eyelid skin incisions.[27–31] However, there were no RCTs comparing Colorado needle electrocautery and scalpel in upper blepharoplasty incisions in terms of bleeding during skin incisions and scarring. No article has described the scar prognosis of Asian versus White patients. Therefore, we previously conducted an RCT on upper blepharoplasty to test our hypothesis. Interventions were performed on the same participant and compared between sides,[12] reducing bias from skin type and genetic effects. The authors decided to study upper blepharoplasty incision before lower blepharoplasty because scars can be hidden in the eyelid crease. In our previous study, Colorado needle electrocautery could reduce intra- and postoperative bleeding and postoperative ecchymosis, but this difference was not clinically significant compared with using the surgical scalpel. We used 3 standard observation scar scales: VSS, POSAS, and Hollander wound evaluation scale.

Lower blepharoplasty is an important part of eyelid surgery that aims to rejuvenate the lower eyelid area. Skin incision is the first step of the procedure, which leaves a scar under the eyelid or in the subciliary position. Some patients do not decide to undergo lower blepharoplasty due to scar concerns.

Only 1 study by Arat et al.[30] compared Colorado needle versus scalpel incision for lower eyelid blepharoplasty, which revealed no significant difference between the 2, but only the Hollander wound evaluation scale was used in scar evaluation. However, the Hollander wound evaluation scale was developed for traumatic wound evaluation, surveillance, and treatment data collection in emergency departments; it was not intended for delicate wounds such as lower eyelid blepharoplasty wounds. Lower eyelid blepharoplasty wounds usually do not have step-off borders, contour irregularity, margin separation, edge inversion, or excessive distortion, as mentioned in the Hollander wound evaluation scale. Furthermore, the overall appearance that mentioned in this scale is not solely based on the incision procedure; rather, it is also affected by procedures, patient factors, and postoperative care.

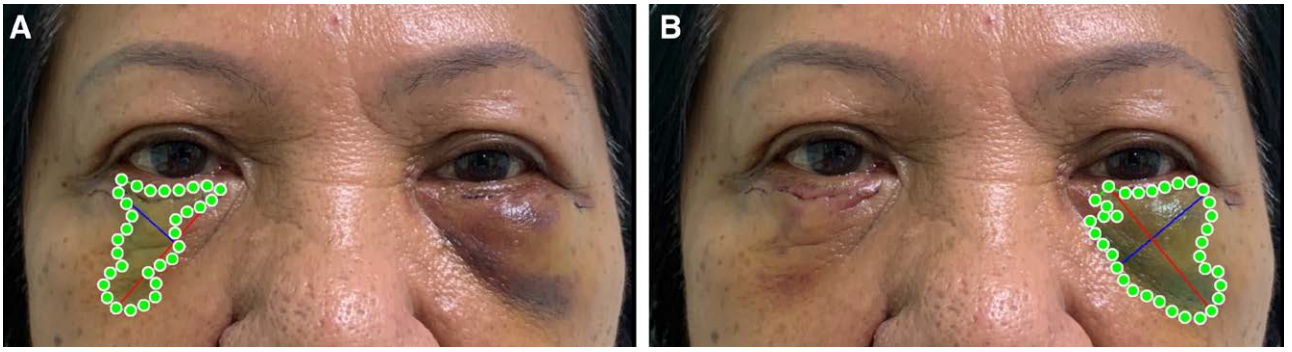

Fig. 6. Postoperative ecchymosis evaluation by using the Wound Doc application. the ecchymosis area was measured in square centimeters. A, Electrocautery. B, Scalpel.

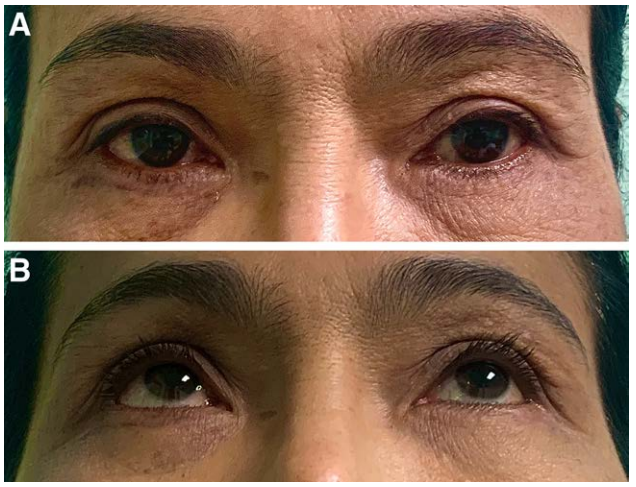

Fig. 7. Hypopigmented scar on the scalpel side (left eye) A, Primary position of eye. B, Eye elevation.

Fig. 8. A photograph of the hyperpigmented scar. A, Hyperpigmented scar on both sides at 1 month postoperatively. B, Hyperpigmented scar only on the electrocautery side (left eye) at 3 months postoperatively.[3]

This study follows the methodology of our previous study.[12] We compared cutting electrocautery with scalpel for lower eyelid blepharoplasty in Thai patients as a representative of the Asian population. The VSS, POSAS, and Hollander wound evaluation scale, which include the observation of patient and surgeon views, were used. Our results are similar to those of our previous study; the electrocautery group reduced operative time by minimizing the skin extraction process time, as well as intraoperative bleeding and postoperative ecchymosis, which are consequences of intraoperative bleeding. Cutting mode electrocautery reduces bleeding during skin incision; this helps because the surgeon does not need to use coagulation mode to stop bleeding in the dermis, which is very thin and can be damaged/scarred by coagulation mode. Notably, bleeding during skin extraction is so minimal that it is difficult to record because no significant differences are observed when it is measured volumetrically. However, in this study, the number of cotton buds used to absorb bleeding during skin incisions had clearly differed. When measured by counting cotton swab sticks, the electrocautery side had a significantly lower average versus the scalpel side (2.6 ± 0.65 versus 5.28 ± 0.68; $P = 0.003$).

Postoperatively, both hypopigmented and hyperpigmented scars were analyzed. Similar to a previous study,[12] long-term scar outcomes in both upper blepharoplasty and lower blepharoplasty incisions were not clinically significantly different between using the Colorado needle electrocauterization (cutting mode) and the surgical scalpel.

Most patients in our study were older adults. In this age group, patients have thin and pliable lower eyelid skin, making precise incisions difficult, sometimes even leading to slanting. Regarding ethnicity, Asian patients tend to have worse scar outcomes than White patients; nevertheless, further study is needed to validate our findings in different ethnicities. If the surgeon opts for the Tran conjunctival approach, electrocautery can also be utilized, as mucosal healing typically yields superior results compared with skin healing.

The advantage of this study is its methodological strength. Half-side comparison RCT is a methodology that can reduce bias from patient genetics. However, because

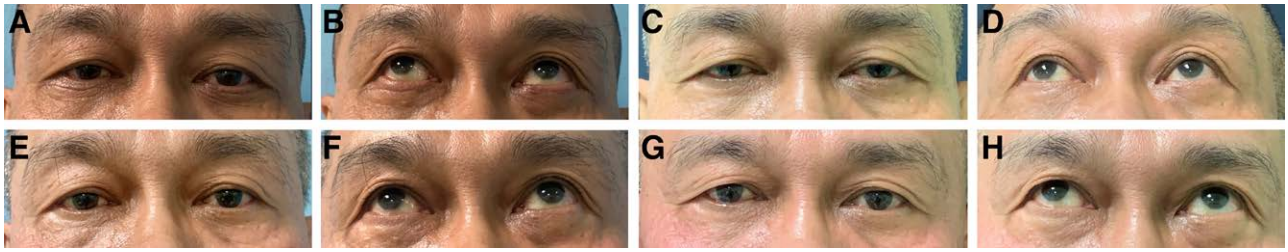

Fig. 9. Example cases. A, Preoperative and postoperative 1-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; primary position of eye. B, Preoperative and postoperative 1-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; eye elevation. C, Postoperative 3-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; primary position of eye. D, Postoperative 3-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; eye elevation. E, Postoperative 6-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; primary position of eye. F, Postoperative 6-month follow-up; right lower eyelid: electrocautery; left lower eyelid: scalpel; eye elevation. G, Postoperative 1-year follow-up; right lower eyelid: electrocautery, left lower eyelid: scalpel; primary position of eye. H, Postoperative 1-year follow-up; right lower eyelid: rlectrocautery; left lower eyelid: scalpel; eye elevation.

all our patients were Thai, our results are limited to this ethnicity.

CONCLUSIONS

Surgeons can safely and efficiently use Colorado needle electrocautery in cutting mode to replace the traditional scalpel for lower eyelid blepharoplasty incision because these techniques have an equal long-term scar effect. Moreover, cutting mode electrocautery has a benefit in hemostasis; it can decrease intraoperative bleeding, which can obscure the incisional site. It eliminates the need to apply pressure or stretch the skin during incision, which in turn decreases postoperative ecchymosis. These traits make it beneficial for lower eyelid blepharoplasty surgery, particularly in older patients who have fragile and wrinkled outer skin.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

Patients provided written consent for the use of their images.

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ETHICAL APPROVAL

The study protocol was registered with the Thai Clinical Trials Registry (TCTR20200222004). All participants provided written informed consent for the publication of their photographs.

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