

ORIGINAL ARTICLE

A new technique of suturing using adhesive skin closure for uncooperative patients

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Abstract

Open wounds are usually closed with suture. However, young patients often do not cooperate and prevent proper suture placement. Young patients are often terrified of mild pain and wholly uncooperative, which is why we introduce this timesaving, less painful, more aesthetic technique of placing and removing stitches. 104 patients with facial lacerations aged 5 to 15 years were treated at a single center from May 2019 to March 2021. Patients were randomly assigned equally to a simple interrupted suture group (the SI group) or a continuous locking with Steri-Strip group (the CS group). Suture times, times for stitch removal, pain scores at stitch removal and mature scar scores were evaluated. Suture and stitch removal times were significantly shorter, and pain scores at stitch removal and observer scar assessment scale scores were lower in the CS group. Patient scar assessment scale score was non-significantly lower in the SI group. This study shows that the novel continuous locking with the Steri-Strip technique is easier and quicker to perform, causes less pain when removing stitches, provides better aesthetic results than the simple interrupted suture technique and suggests the continuous locking with Steri-Strip technique would be very useful for uncooperative young patients.

KEYWORDS

adhesive surgical tape, cicatrix, laceration, suture technique

Key Messages

- we are going to introduce 'continuous locking suture with Steri-Strip' for young and uncooperative patients
- this is less painful, time saving and provides good results in terms of scar
- this study was performed in a single center, and subjects were between 5 and 15 years old

1 | INTRODUCTION

Suture techniques vary widely and are used during many procedures. Surgeons must be familiar with those

techniques, especially when dealing with trauma and surgery. Sutures are used to close open wounds, suppress infection and consequently minimise scar formation.^{1,2} Many suturing techniques described all have their pros

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and cons,³⁻⁷ and many doctors, especially plastic surgeons, continue to devise methods minimising scarring after open wound healing. Recent studies show some factors such as less physical tension, accurate margins and stitch removal without any additional trauma can reduce scarring.^{8,9} These conditions may be easily met when adult patients are cooperative but are considerably more difficult to achieve in young uncooperative patients.¹⁰ Therefore, we introduce a 'continuous locking with Steri-Strip suture technique (CS)', which is quick, less painful, aesthetically useful and an ideal option for the uncooperative patients.

2 | METHODS

2.1 | Study design

This prospective, randomised, single-blinded study was conducted on 104 patients recruited at a single center from May 2019 to March 2021. All patients were East Asian and were classified as types 3 to 4 in the Fitzpatrick classification.¹¹ They were between 5 and 15 years old. All had an open wound in their facial area caused by a traumatic accident requiring surgical intervention such as primary repair. These 104 subjects were assigned randomly and equally to two groups by a computer program. In group A, wounds were treated using the 'simple interrupted suture technique (the SI group)' in a traditional manner, and in group B, wounds were treated using the devised 'continuous locking with *Steri-Strip* suture technique (the CS group)'. Patients that met the following criteria were excluded from the study: 1) A laceration on the mucosal surface of a lip or on a hairy area, which were not expected to maintain *Steri-Strip*; 2) Prior treatment for a hypertrophic scar or keloid; 3) A disease that might affect the wound healing process such as Down syndrome, Klinefelter syndrome or a vasculopathy^{12,13} and 4) those not monitored for at least six months after surgery.

Suture times and times required to remove all stitches were recorded, and pain at stitch removal was measured using the *Wong-Baker* faces pain rating scale. In general, it is known that children aged 4–12 years can express pain, and we used this scale because of the ages of our patients. This scale utilizes 6 hand-drawn, cartoon-like, sex-neutral faces that express a pain range from no pain (a smiling face) to worst pain (a crying face).¹⁴

The subjects were required to visit our center at least 6 months after surgery when they completed the Patient Scar Assessment Scale (PSAS) and the 4-point scale assessments. And two independent observers, that is, two plastic surgeons unaware of group allocations, assessed the patients' scar using the Observer Scar Assessment Scale (OSAS) and the 4-point scale in a blinded manner.¹⁵⁻¹⁷ The PSAS

consists of six items (colour, pliability, thickness, relief, itching and surface area), and each item is rated using a 10-point scale. OSAS has 6 items (vascularity, pigmentation, pliability, thickness, relief and surface area), which are also rated using a 10-point scale, where 1 = resembling normal skin and 10 = worst imaginable scar appearance; thus total possible scores range from a minimum of 6 to a maximum of 60. The 4-point scale classifies scars as 'excellent' (4, no obvious scarring, atrophic or indurated, or slightly red or not as compared with adjacent skin), 'good' (3, no obvious scarring, atrophy or induration and/or moderate redness or an increase in pigmentation versus adjacent skin), 'fair' (2, slight to moderate scarring, atrophic, indurated and/or significant redness or an increase in pigmentation versus adjacent skin) or 'poor' (1, extensive scarring, atrophic, indurated and/or redness or an increase in pigmentation as compared with adjacent skin).¹⁶ A high score of the 4-point scale means a skin similar to normal skin. The patients provided written informed consent for the publication and the use of their images. The study was approved by the Institutional Review Board of Dongguk University Hospital (IRB No.IRB;approval # 110757-201 911-HR-01-04) and performed in accordance with the principles of the Declaration of Helsinki.

2.2 | Surgical technique

Local anaesthesia was achieved using lidocaine hydrochloride 1% and epinephrine 1:100000 for all procedures. Non-viable tissue was debrided. All lacerations were repaired in layers using absorbable materials to minimise tension. Skin was closed with non-absorbable monofilament sutures (*Nylon 6-0*) with 4 mm intervals between sutures. Additional steps were required in the CS group. Before skin repair, two sheets of *Steri-strip* (6 mm × 100 mm, reinforced, R1546, 3M) were attached parallel to and at a distance of 1–2 mm from one side of a laceration, and then a continuous locking suture was started using one interrupted stitch. All knots were located on the *Steri-Strip* (Figure 1). In all cases, the procedure was performed by one plastic surgeon alone.

Stitches were removed in all 104 cases at 5 days after initial skin repair. A No. 11 blade was used in the SI group, and a pair of small scissors (eg. Iris scissors) were used to cut sutures in the CS group. All stitches were removed with attached *Steri-Strip* (Figure 2).

2.3 | Statistical analysis

The significances of differences between categorical variables in the SI and CS groups were determined using the



FIGURE 1 A, Drawing representing the continuous locking with Steri-Strip suture technique. B,C, Laceration on chin and forehead demonstrating this technique

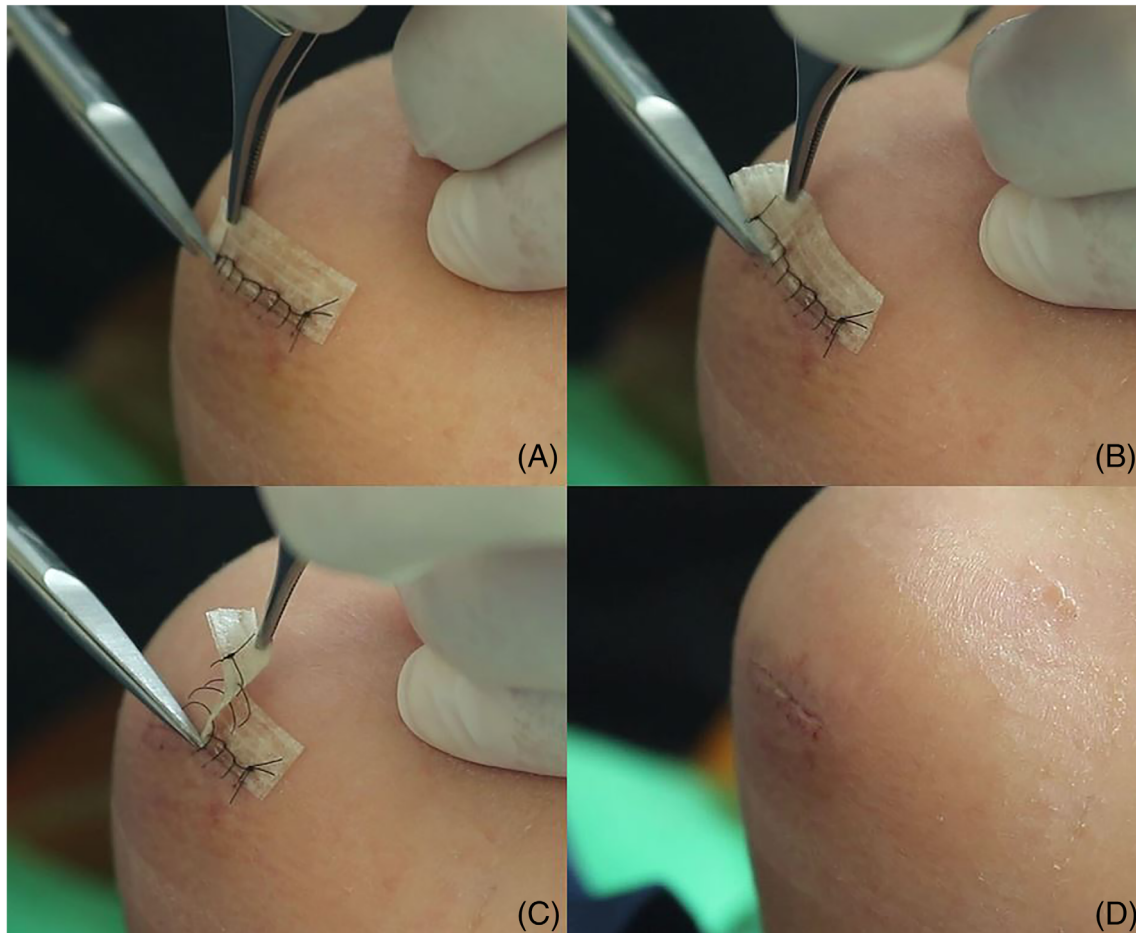


FIGURE 2 Procedure of stitch removal of continuous locking with the Steri-Strip suture technique. A, When the first knot is cut by small scissors. B, Then the tension on the next knot is naturally released. C, All debris of the sutures is removed while taking off the Steri-Strip. D, During all stitches were remove, the patient did not feel any pain

Chi-square test and the Chi-square test for trend, and those of differences between continuous variables were determined using the *t*-test for independent samples for

normally distributed variables or the Mann-Whitney *U* test for non-normally distributed variables. The data analysis was performed using IBM SPSS Statistics ver.

TABLE 1 Baseline characteristics in the two study groups

Characteristics	Category	SI group(n = 52)		CS group(n = 52)	
		N	%	N	%
Sex	Male	42	80.8	36	69.2
	Female	10	19.2	16	30.8
Follow-up duration(mean month)	≤12 month	7(7.75)	13.5	15(8.71)	28.8
	>12 month	45(21.1)	86.5	37(21.2)	71.2
Mean age(yr ± SD)		7.96 ± 2.8		7.27 ± 2.4	

Note: There were no statistically significant differences in gender, follow-up period and age between the two groups.

Abbreviations: CS, continuous locking with Steri-Strip suture; N, number; SD, standard deviation; SI, simple interrupted suture; yr, years.

	SI (N)	CS (N)
Forehead	10	12
Temple	5	5
Periorbital	6	5
Zygoma	4	2
Nose	2	3
Infraorbital	3	4
Mandibular	5	3
Perioral	5	5
Chin	12	13

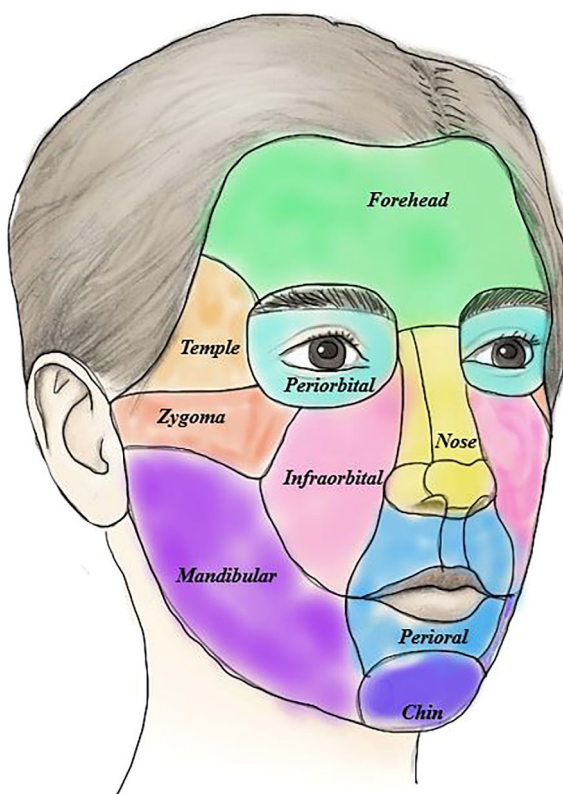


FIGURE 3 The frequency of laceration for each facial region. There were a total of 104 laceration, and the forehead and chin were the most common. Eyebrows and lips were excluded from the study CS, continuous locking with Steri-Strip suture; N, number; SI, simple interrupted suture

25.0 for Windows, and statistical significance was accepted for P -values <0.05 .

3 | RESULTS

Primary repairs were performed from May of 2019 to March of 2021. A total of 104 patients aged from 5 to 15 years were included and equally allocated to the SI or CS groups. Patient baseline characteristics are shown in Table 1 and Figure 3. There were more males than females in both groups (SI Group: male ($n = 42$, 80.8%), CS Group: male ($n = 36$, 69.2%), $P = 0.174$). Patients were observed for at least 6 months and up to 31 months

after surgery and were subdivided about 12 months after surgery (SI group: ≤ 12 months ($n = 7$), > 12 months ($n = 45$); CS group: ≤ 12 months ($n = 15$), > 12 months ($n = 37$), $P = 0.055$).

Mean (\pm SD) wound length was 2.35 (± 1.1) cm in the SI group and 2.80 (± 1.5) cm in the CS group ($P = 0.08$). There was no statistical difference between the two groups. Mean suturing times were 213.1 \pm 113.6 s in the SI group and 168.8 \pm 72.4 s in the CS group, respectively ($P < 0.05$), and suture removal times were 65.6 \pm 45.0 in the SI group and 18.6 \pm 8.6 s in the CS group, respectively ($P < 0.05$). Times for suturing and suture removal were shorter in CS group than in SI group with statistical significance (Table 2).

TABLE 2 Length of wounds and suture and stitch removal time

Characteristic	SI group	CS group	P-value
Mean length \pm SD (cm)	2.35 \pm 1.1	2.80 \pm 1.5	0.08
Mean suture time \pm SD (sec)	213.2 \pm 113.6	168.8 \pm 72.3	<0.05
Mean stitch removal time \pm SD (sec)	65.65 \pm 45.0	18.6 \pm 8.6	<0.05

Abbreviations: CS, continuous locking with Steri-Strip suture; SD, standard deviation; SI, simple interrupted suture.

Pain scores at stitch removal

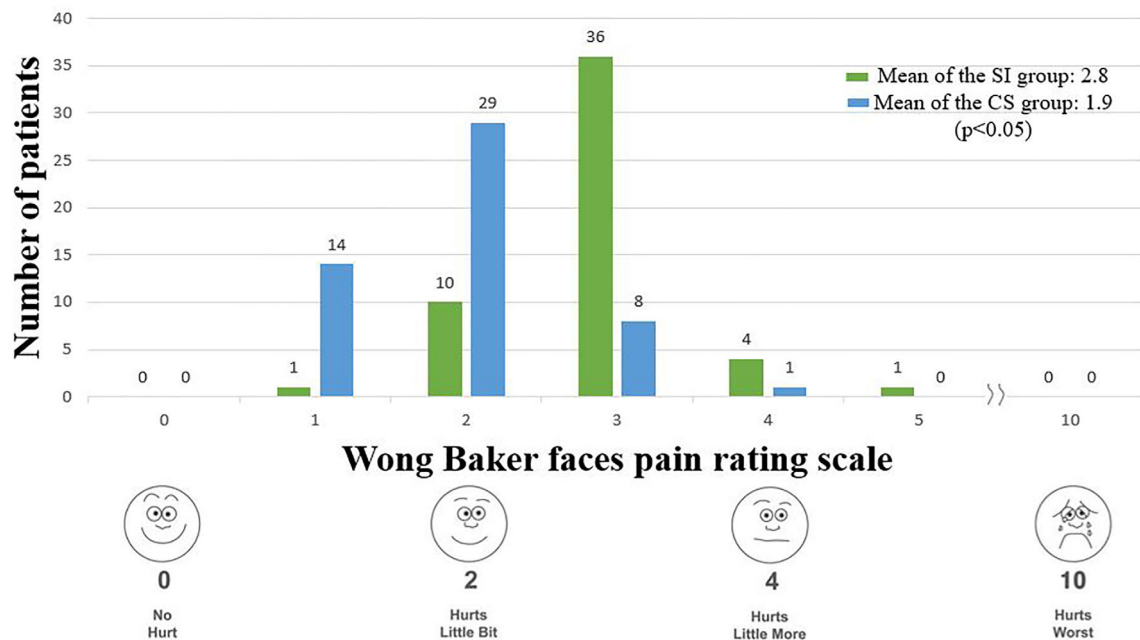


FIGURE 4 The pain scores at stitch removal evaluated by Wong-baker face pain rating scale in the two groups. This pain scale can be measured from 0 to 10, but 6 to 9 points were skipped. CS, continuous locking with Steri-Strip suture; N, number of patients; SI, simple interrupted suture

Mean Wong-Baker face pain rating score during removal of stitches was significantly lower in the CS group (SI group: 2.9 ± 0.6 , CS group: 1.92 ± 0.7 , $P < 0.05$) (Figure 4).

Table 3 shows aesthetic results for scars at least 6 months after surgery. Patient-assessed PSAS scores showed no significant difference between the SI group and the CS group (SI group: 14.6 ± 7.2 , CS group: 14.7 ± 7.0 , $P = 0.90$), but OSAS scores were significantly lower in the CS group (SI group: 9.0 ± 3.3 , CS group: 7.8 ± 2.2 , $P < 0.05$). 4-point scores as determined by patients or their parents (mean scores in the SI and CS groups were 2.75 and 2.85, respectively) were non-significantly different ($P = 0.59$), 4-point system scores awarded by the two independent observers were significantly higher in the CS group (mean SI and CS group scores were 2.67 and 2.98, respectively, $P < 0.05$).

4 | DISCUSSION

Many techniques can be used to close lacerations and the advantages and disadvantages of these techniques are well known to physicians.⁷ However, it is always difficult for surgeons to conduct any of these techniques optimally in uncooperative patients, and this is especially the case in paediatric patients who are invariably sensitive to pain. In addition, the environment in which procedures are performed coupled with pain experienced may cause young patients to panic, and of course, this situation is repeated when removing stitches. In this prospective study, we attempted to prove the usefulness of our new technique by assessing suture and suture removal times, pain scale scores and aesthetic results in young patients who had facial laceration, treated with simple interrupted sutures or the described continuous locking with Steri-Strip suturing technique.

Scale	SI group	CS group	P-value
Patient assessment			
PSAS; mean (range)	14.5(6–40)	14.7(6–34)	0.90
4-point scale; mean (range)	2.75(1–4)	2.85(1–4)	0.58
Observer assessment			
OSAS, mean (range)	9.0(6–17)	7.8(6–14)	<0.05
4-point scale; mean (range)	2.67(1–4)	2.98(1–4)	<0.05

TABLE 3 Scar assessment score scale

Abbreviations: CS, continuous locking with Steri-Strip suture; OSAS, observer scar assessment scale; PSAS, patient scar assessment scale; SI, simple interrupted suture.

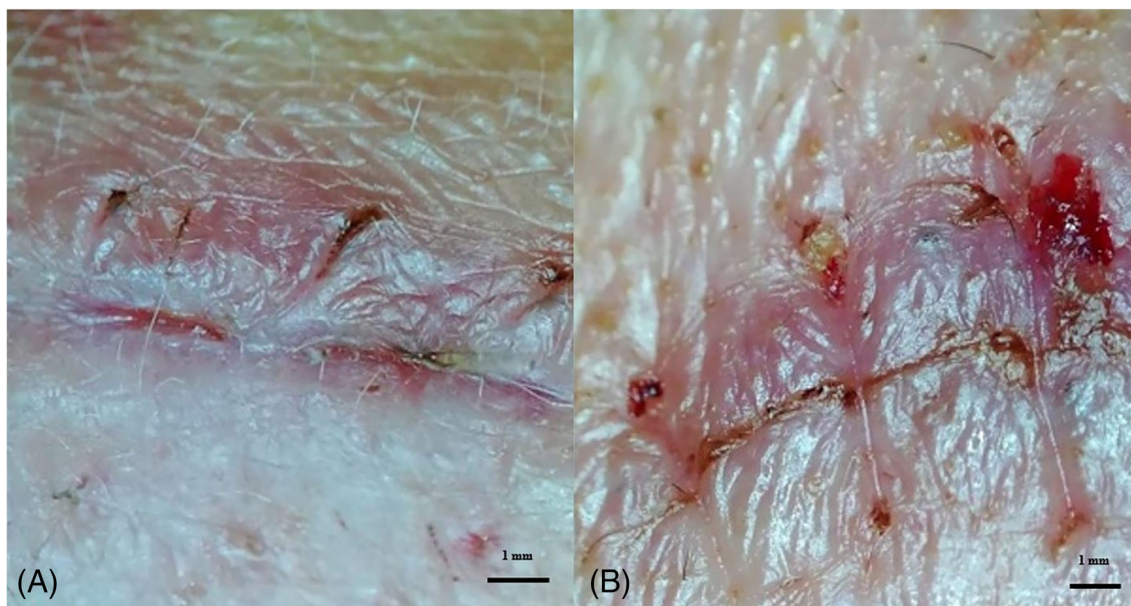


FIGURE 5 Microscopic photos after stitch removal. A, Photograph taken after continuous locking with Steri-Strip suture removal on postoperative day 5, showing no suture marks on the lower side where Steri-Strip was applied B, After removal of all stitches on postoperative day 5, obvious suture marks were present on the forehead of a patient in the simple interrupted suture group

In some cases, some sedative drugs are used to calm uncooperative patients, but this must be minimized to reduce risk of side-effects,¹⁸ which also means suture times must be minimised. The running suture technique is simpler than the simple interrupted suture technique and thus, takes less time. The continuous locking suture technique is a type of running suture, which is why suture times were shorter in the CS group, as indicated by our results. The simple interrupted suture technique and the continuous locking suture technique have similar degrees of difficulty, and thus, the continuous locking suture technique is suitable for beginners and can be performed without assistance because continuous knots are made, and cutting is not required after each suture, which substantially reduces manpower requirements.

Stitch removal is usually accompanied by pain, and in young children, even mild pain can cause them to lose control. For example, one patient in the SI group received

an additional laceration to his right hand by a No. 11 blade during removal of forehead sutures that required additional suturing. However, the removal of sutures in our new technique group, which are continuous locking sutures characterised by two knots, one at the beginning and another one at the end, is less painful than simple interrupted suture removal. Cutting of the first loop of a continuous locking suture reduces tension in the connected loop, which creates a gap for scissors insertion without pulling on stitches, and thus, minimizes pain, and the Steri-Strip is removed almost painlessly while sequentially removing loose sutures. We suggest that small scissors be used during stitch removal after the Steri-Strip suturing procedure to even prevent the instrument contacting skin directly (Figure 2).

The goal of accurate and safe suture techniques is to leave fewer scar.² Although evaluating aesthetic results is always difficult because there is no gold standard, in this

study, aesthetic results were obtained through comparison of the POSAS and 4-point scales. POSAS has been shown to be an appropriate subjective tool for evaluating linear scars.¹⁶ In the present study, patient-reported aesthetic results and observer-evaluated results showed that patient assessed aesthetic results were similar between the two groups, and that observer assessed results were better in the CS group.

Continuous locking sutures can leave more suture marks than simple interrupted sutures because the suture thread along the wound can impair the microcirculation and leave marks. However, by placing Steri-Strip between the suture and skin, direct pressure is dispersed, and as a result, no obvious suture marks were observed (Figure 5). We suggest, although time to stitch removal was only 5 days for facial skin in this present study, our new technique would be more effective than simple interrupted sutures in the trunk or upper or lower extremities requiring the longer times for stitch removal.¹⁹ Recently, there have been many zippers instead of sutures, but they are used for relatively shallow laceration. Our new suture method is easy to fit each layer to treat laceration in deeper layers and technically makes it easy to evert lacerated skin. It also requires only inexpensive materials compared with commercialized devices. This is because only a part of the Steri-Strip used to prevent scar formation after removing sutures is used in advance. In conclusion, we expect that our new suturing technique would be highly effective at preventing suture marks and cost effective.

Several limitations of this study need to be mentioned. First, this study was mainly conducted in flat areas of the face without hair. Patients with a laceration in hair-bearing skin or a mucosal region were excluded because it is difficult to maintain Steri-Strip in these areas. Second, the total sample size was relatively small because long-term follow-up was required and only facial wounds were included. Third, patients under 5-year old were not included in this study. We found their increased pain sensitivity and excessive fear during suture removal in young children under 5 years old. But according to our result, we believe that the continuous locking with Steri-Strip suture method is more useful in children under 5 years old considering less pain.

Nonetheless, the study demonstrates the effectiveness and usefulness of the continuous locking with the Steri-Strip suturing technique. We suggest a larger-scale study be conducted on patients with lacerations in other body regions and children under 5 years old.

5 | CONCLUSION

Doctors should make considered decisions regarding best choices for open wound treatment. This randomized

controlled trial showed that the devised continuous locking with the Steri-Strip suturing technique provided better outcomes for lacerations in the facial area. This method was found to significantly shorten total procedure times, reduce pain, and improve aesthetic outcomes. Therefore, it is an excellent option for uncooperative young patients.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

AUTHORS CONTRIBUTIONS

Joon-Shik Hong and Hea-Kyeong Shin jointly conceived the study. Joon-Shik Hong designed the study with support from Hea-Kyeong Shin, obtained relevant ethical approvals, conducted patient interviews and the data analysis and wrote the initial draft of the manuscript. Hea-Kyeong Shin supported Joon-Shik Hong during the study design stage and data analysis, assisted with ethical approvals and made substantial amendments to the manuscript. Seok-Ju Yoo contributed to the data analysis. All authors read and approved the manuscript.

DATA AVAILABILITY STATEMENT

The Data Availability Statement must specify that data are deposited publicly and list the name(s) of repositories along with digital object identifiers or accession numbers for the relevant data sets.

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