Published in final edited form as:

J Am Acad Dermatol. 2015 April ; 72(4): 668–673. doi:10.1016/j.jaad.2014.11.032.

Does wound eversion improve cosmetic outcome?:

Results of a randomized, split-scar, comparative trial

Stefani Kappel, MD^b, Rebecca Kleiner, MD^c, Thomas H. King, MD^a, Raja Sivamani, MD^a, Sandra Taylor, PhD^d, UyenThao Nguyen, MS^d, and Daniel B. Eisen, MD^a

^aDepartment of Dermatology, University of California, Davis, Sacramento

^bLaser and Skin Surgery Center of Northern California, Sacramento

^cSchweiger Dermatology, New York

^dClinical and Translational Science Center, University of California, Davis, Sacramento

Abstract

Background—Wound edge eversion has been hypothesized to improve aesthetic outcomes after cutaneous wound closure. Data supporting this assertion are sparse.

Objective—We sought to determine if wound eversion, achieved with interrupted subcuticular sutures, improves aesthetic outcome compared with planar closures.

Methods—We undertook a prospective, randomized, split-scar intervention in patients who underwent cutaneous surgery. Half of the wound was randomized to an everted or planar repair; the other side received the opposite one. At 3- and 6-month follow-up, both the patient and 2 blinded observers evaluated the wound using the Patient Observer Self-Assessment Scale (POSAS).

Results—The total observer POSAS score for the everted (13.59, 12.26) and planar (12.91, 12.98) sides did not differ significantly at 3 or 6 months, respectively. Similarly, there was not a significant difference in patient assessment between the everted (16.23, 12.84) and planar (15.07, 12.79) sides at 3 or 6 months, respectively. Finally, there was no significant difference between the 2 closure methods in terms of scar height or width at follow-up.

Limitations—This was a single-center trial, which used a validated but still subjective scar assessment instrument.

Conclusion—Wound eversion was not significantly associated with improved overall scar assessments by blinded observers or patient assessment.

Keywords

cosmesis; eversion; inverted vertical mattress suture; Patient Observer Self-Assessment Scale; set-back suture; surgical scars

Wound edge eversion is espoused as providing superior cosmetic outcomes after cutaneous surgery.¹⁻⁴ Eversion purportedly counteracts the natural tendency of sutured wounds to form depressed scars, which result from contractile forces during healing.¹⁻³ As a result, many suturing techniques,⁵⁻⁸ which evert wound edges, have been described.

Data supporting improved outcomes with eversion are limited. No studies, to our knowledge, have directly addressed this facet of wound closure. Instead only surrogate outcomes comparing suturing techniques that evert edges more than traditional suturing techniques have been performed. Moody et al⁹ demonstrated cosmetic superiority using running horizontal cuticular mattress sutures over simple running sutures. However, their study did not directly measure eversion and their outcomes may have been biased by confounders, such as cutaneous track marks.

We sought to determine whether wound eversion, achieved by careful placement of dermal sutures alone, would improve cosmetic outcomes after cutaneous surgery. To mitigate the confounding influence of track marks, resulting from various cuticular suturing methods, we used only adhesive strips to re-approximate the epidermis (Steri-strips, 3M Healthcare, St. Paul, MN).

METHODS

Study design

We conducted this prospective, single-center, evaluator-blinded, randomized split-scar comparison trial between July 2012 and May 2013. The University of California, Davis Institutional Review Board approved this registered study (ClinicalTrials.gov Identifier: NCT01770002) and written informed consent was obtained from all patients before enrollment.

Power analysis and randomization

To detect a difference of 4 on the 60-point observer scar assessment scale with an assumed SD of 7.6,¹⁰ alpha of 0.05, and power of 90, we calculated we would need to enroll at least 40 patients. Anticipating at least a 20% dropout rate because of the study length, we recruited 50 patients into the study.

Patients were randomized using a World Wide Web-based service based on atmospheric noise (www.random.org). The randomization list was generated before study subject recruitment and kept in a folder in a separate room by a nurse not involved in the study. After recruitment and labeling of the wound as A (left/superior) or B (right/inferior), the nurse would consult the list and provide the surgeon with which side would receive planar closure and which side would receive eversion. After recruitment the list was destroyed. The intervention method for each side was recorded for every patient at the time of the procedure in a World Wide Web-based data collection form (REDCap).¹¹ Concealment was maintained by having the university database administrator remove permission from the allocation sequence-recording page from all study personnel until after study completion.

Patients

Inclusion criteria were: age 18 years or older with postoperative defects of at least 3 cm, resulting from either Mohs micrographic surgery or surgical excision at the University of California, Davis, outpatient dermatology clinic. Eligible subjects were able to give informed consent and were willing to return for follow-up visits at 3 and 6 months after surgery. Exclusion criteria included: pregnancy, incarceration, mental impairment, inability to understand English, and nonlinear closures. To improve external validity, postoperative defects were not limited to an anatomic location and surgeons of different experience levels were included (residents, fellows, faculty).

Interventions

Side A of each wound was randomized to receive either planar or everted closure (Fig 1). Side B received the opposite of A. The everted half was sutured using a dermal set-back or inverted vertical mattress suture, depending on surgeon preference. The other half was closed with a simple buried cuticular suture. By convention side A was always superior or left from the surgeon's perspective and side B was the opposite. Before suturing, any bevels were excised and the wound edge undermined as necessary per surgeon preference. After wound closure, adhesive strips were placed after application of a supplemental adhesive (Mastisol, Eloquest Healthcare Laboratories, Detroit, MI) to both sides of the wound. Patients were instructed to apply petroleum jelly to both sides of their wound twice daily for 1 week with a cotton-tipped applicator.

Assessment intervals and efficacy outcomes

Because differences between surgical interventions tend to diminish in the long-term we sought to evaluate our patients in the near and mid-term at 3 and 6 months.¹² We reasoned if differences were not detectable by these time points then they would not be at a more distant time when patient dropout would likely increase and study quality decrease.

Wound edge eversion was measured immediately after surgery for both sides using a ruler at the midpoint of each intervention side; we recorded both height and width of the everted tissue for both sides. The primary end points of the study were the POSAS scores at the first and second follow-up periods. This instrument has been validated and used in several cutaneous surgery studies and provides both patient and observer scar assessments without a training requirement.^{13–15}

Secondary outcome measures included height and width of the scar as compared with the surrounding unaffected skin surface. Measurements were made at the midpoint of each intervention. All complications and adverse events were monitored and recorded for each side of the scar. Two blinded observers performed assessments of the scar and their scores were averaged. Data were captured and managed using a World Wide Web-based data collection page (REDCap).¹¹

Statistical methods

We compared mean POSAS scores for the 2 wound closure techniques separately at 3 and 6 months using a paired Wilcoxon test. False discovery rates were calculated to account for

multiple testing. Paired Wilcoxon tests also were used to compare differences in scar height, width, and depth between the 2 closure techniques at 3 and 6 months. In addition, because scar height and depth were 0 for many patients, McNemar test was used to test for differences in the proportion of scars with measureable heights and depths between the 2 closure methods. Statistical analyses were conducted using R statistical computing software (R Foundation for Statistical Computing, Vienna, Austria). Study outcomes were calculated using the intent-to-treat principle with the last observation carried forward for patients missing 6-month follow-up data.

RESULTS

A total of 60 patients were screened for participation in our study. Ten patients were excluded for various reasons (Fig 2). About half of the 50 patients were enrolled after undergoing Mohs micrographic surgery and the other half after surgical excision. The fellow performed the study intervention in the majority of cases, the rest were done by first-, second-, and third-year residents and attending physicians (Table I). All interventions involving the residents were performed under the direct supervision of an attending physician who oversaw, but did not perform, the closures. About half of the fellow's interventions were directly supervised.

Of the 50 patients enrolled, 47 patients were available at the 3-month assessment and 43 completed the 6-month assessment. Demographic data are supplied in Table I. Our study population largely reflects those who undergo most cutaneous surgical procedures at our institution: older Caucasians with a slight male predominance.

Reviewer POSAS scores for the 2 closure techniques did not significantly favor the everted side (false discovery rate >0.05) for vascularity, pigmentation, thickness, relief, pliability, surface area, or overall opinion at 3- or 6-month assessment (Table II). Similarly, at 3- and 6-month time points, none of the patient POSAS scores differed significantly between the 2 wound closure methods for pain, pruritus, color, stiffness, thickness, irregularity, and overall impression (Table III).

For the other end points of height, depth, and width of the scars at 3 and 6 months, there were no statistically significant differences (false discovery rate >0.05) between the everted and flat sides of the scars as described in Table IV. Although the mean height of the planar and everted sides immediately after surgery was 0.7 mm and 4 mm, respectively, by 3 months scar height was 0 for most patients regardless of closure method (38 of 47 patients for the planar side and 30 of 47 for the everted side). By 3 months, scar depth was 0 in nearly all patients (44 of 47 for the planar side and 45 of 47 for the everted side). Of the 43 patients observed at 6 months, scar depth was 0 for 39 of the planar sides and the same for 40 of the everted sides.

DISCUSSION

Our study found that the use of wound eversion achieved with buried dermal sutures alone did not improve the overall cosmetic outcome of scars resulting from cutaneous surgery over

that of planar closure, as judged by 2 blinded observers. Similarly, the patient's own scar assessment showed no difference between the everted and planar closure methods.

We were unable to find any other randomized trials in PubMed or Google Scholar that compare outcomes of planar and everted wound closures. Despite long-standing recommendations regarding wound eversion, only indirect evidence exists to support it.^{9,16}

One limitation of our study includes its single-center nature. A multicenter trial would have expanded our study population and increased the study's external validity. In addition, our primary outcome measure, although validated, is largely subjective. Furthermore, we allowed multiple treatment areas. Although it has not been definitively proven, different anatomic areas may respond differently to the effects of eversion. Although the variety of physicians may be a potential limitation, this increased the study's external validity.

A strength of our study includes the mitigation of the effects of suture tracks by avoiding the use of cuticular sutures. Without cuticular sutures, track marks were physically impossible. Also, wound eversion was measured directly, unlike prior studies. The use of blinded observers, an a priori power analysis, intervention concealment, and a validated scar assessment instrument further increased the quality of our investigation.¹⁻¹⁴ Thus, despite the limitations of our study, we believe the overall quality of its design and execution make our conclusions of value.

Conclusion

Cosmetic outcomes appear to be similar whether wound edges are everted or not. Traditional dogma regarding this basic tenet of dermatologic surgery is unsupported by our findings. Efforts to improve cosmetic outcomes after cutaneous surgery should focus on facets of wound closure, other than eversion.

We are indebted to Audrey Wang, Mondhipa Ratnarathorn, Cindy Chambers, Oma Agbai, Jayne Joo, Anabella Pascucci, Larissa Larsen, Sarah Fitzmaurice, Shurong Chang, Renu Rehal, and Mary Ann Johnson for their efforts in conducting the study. In addition, we would like to thank Lam Nguyen for crucial administrative support.

Acknowledgments

Supported by the National Center for Advancing Translational Sciences, National Institutes of Health, through grant #UL1 TR000002.

References

1. Moy RL, Waldman B, Hein D. A review of sutures and suturing techniques. *J Dermatol Surg Oncol*. 1992; 18:785–795. [PubMed: 1512311]
2. Alam M, Goldberg LH. Utility of fully buried horizontal mattress sutures. *J Am Acad Dermatol*. 2004; 50:73–76. [PubMed: 14699369]
3. Zide MF. Scar revision with hypereversion. *J Oral Maxillofac Surg*. 1996; 54:1061–1067. [PubMed: 8811815]
4. Kronic AL, Weitzul S, Taylor RS. Running combined simple and vertical mattress suture: a rapid skin-everting stitch. *Dermatol Surg*. 2005; 31:1325–1329. [PubMed: 16188188]

5. Zuber TJ. The mattress sutures: vertical, horizontal, and corner stitch. *Am Fam Physician*. 2002; 66:2231–2236. [PubMed: 12507160]
6. Baker, SR. Wound closure techniques. In: Baker, SR., editor. *Local flaps in facial reconstruction*. Philadelphia (PA): Mosby; 2007. p. 45
7. Hruza, GJ. Suturing techniques. In: Lask, G.; Moy, R., editors. *Principles and techniques of dermatologic surgery*. New York (NY): McGraw-Hill; 1996. p. 171-185.
8. Kantor J. The set-back buried dermal suture: an alternative to the buried vertical mattress for layered wound closure. *J Am Acad Dermatol*. 2010; 62:351–353. [PubMed: 20115960]
9. Moody BR, McCarthy JE, Linder J, et al. Enhanced cosmetic outcome with running horizontal mattress sutures. *Dermatol Surg*. 2005; 31:1313–1316. [PubMed: 16188185]
10. Cromi A, Ghezzi F, Gottardi A, et al. Cosmetic outcomes of various skin closure methods following cesarean delivery: a randomized trial. *Am J Obstet Gynecol*. 2010; 203:36. [PubMed: 20417924]
11. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009; 42:377–381. [PubMed: 18929686]
12. Alam M, Posten W, Martini MC, Wrone DA, Rademaker AW. Aesthetic and functional efficacy of subcuticular running epidermal closures of the trunk and extremity: a rater-blinded randomized control trial. *Arch Dermatol*. 2006; 142:1272–1278. [PubMed: 17043181]
13. Vercelli S, Ferriero G, Sartorio F, et al. How to assess postsurgical scars: a review of outcome measures. *Disabil Rehabil*. 2009; 31:2055–2063. [PubMed: 19888834]
14. Falder S, Browne A, Edgar D, et al. Core outcomes for adult burn survivors: a clinical overview. *Burns*. 2009; 35:618–641. [PubMed: 19111399]
15. Idriss N, Maibach HI. Scar assessment scales: a dermatologic overview. *Skin Res Technol*. 2009; 15:1–5. [PubMed: 19152571]
16. Eleftheriou LI, Weinberger CH, Endrizzi BT, et al. The victory stitch: a novel running v-shaped horizontal mattress suturing technique. *Dermatol Surg*. 2011; 37:1663–1665. [PubMed: 21967500]

Fig 1. Wound immediately postoperative (*left*) and at 3-month follow-up (*right*). *POSAS*, Patient Observer Self-Assessment Scale.

Fig 2.
Screening, enrollment, and follow-up of study patients.

Table I

Demographics and surgery data such as SD, n (%), median (interquartile range)

Male, %	58.5
Mean age, y	61.8 ± 11.9
Median age, y	62
Race	American Indian/Alaskan 1 (1.9%)
	Asian 0 (0%)
	Pacific Islander 1 (1.9%)
	African American 1 (1.9%)
	Caucasian 49 (92.5%)
	Unknown 1 (1.9%)
Location	Forehead 1 (2%)
	Scalp 5 (10%)
	Cheeks 4 (8%)
	Neck 13 (26%)
	Arm 11 (22%)
	Leg 2 (4%)
	Back 11 (22%)
	Chest 3 (6%)
Mean wound closure length, cm	6.1 ± 2.2
Surgeon experience	Attending 10 (19.6%)
	Fellow 34 (66%)
	Resident 7 (13.7%)
Indication	Mohs 24 (48.5%)
	Excision 26 (52%)

Table IIPOSAS results at 3- and 6-month follow-up; means ($\pm$ SD) and *P* values from the paired comparisons

Components at 3 mo	Mean ($\pm$ SD)		FDR	Raw <i>P</i> value
	Everted	Planar		
Vascularity	2.72 ($\pm$ 1.64)	2.88 ($\pm$ 1.66)	0.96	.41
Pigmentation	1.76 ($\pm$ 0.86)	1.80 ($\pm$ 0.92)	0.96	.82
Thickness	2.40 ($\pm$ 1.17)	2.18 ($\pm$ 1.20)	0.96	.29
Relief	2.17 ($\pm$ 1.07)	1.90 ($\pm$ 0.98)	0.96	.20
Pliability	2.34 ($\pm$ 1.17)	2.20 ($\pm$ 1.05)	0.96	.69
Surface area	2.34 ($\pm$ 1.23)	2.36 ($\pm$ 1.46)	0.96	.87
Sum of POSAS	13.73 ($\pm$ 5.41)	13.33 ($\pm$ 6.06)	0.96	.62
Overall score	2.53 ($\pm$ 1.30)	2.53 ($\pm$ 1.54)	0.96	.96

Components at 6 mo	Mean ($\pm$ SD)		FDR	Raw <i>P</i> value
	Everted	Planar		
Vascularity	2.44 ($\pm$ 1.10)	2.5 ($\pm$ 1.05)	0.70	.53
Pigmentation	1.77 ($\pm$ 0.76)	1.80 ($\pm$ 0.92)	0.91	.91
Thickness	1.93 ($\pm$ 0.97)	2.08 ($\pm$ 1.16)	0.44	.27
Relief	2.0 ($\pm$ 0.96)	2.03 ($\pm$ 1.10)	0.88	.77
Pliability	1.87 ($\pm$ 0.87)	2.01 ($\pm$ 1.11)	0.39	.12
Surface area	2.41 ($\pm$ 1.34)	2.58 ($\pm$ 1.39)	0.39	.20
Sum of POSAS	12.42 ($\pm$ 4.73)	13.05 ($\pm$ 5.60)	0.39	.18
Overall score	2.36 ($\pm$ 1.33)	2.64 ($\pm$ 1.37)	0.39	.10

FDR, False discovery rate; *POSAS*, Patient Observer Self-Assessment Scale.

Table IIIPOSAS results at 3-and 6-month follow-up; means ($\pm$ SD) and *P* values from the paired comparisons

Components at 3 mo	Mean ($\pm$ SD)		FDR	Raw <i>P</i> value
	Everted	Planar		
Pain	1.32 ($\pm$ 1.10)	1.28 ($\pm$ 0.97)	0.86	.86
Itching	1.47 ($\pm$ 1.28)	1.38 ($\pm$ 1.17)	0.84	.60
Color	3.96 ($\pm$ 2.75)	3.91 ($\pm$ 3.12)	0.84	.63
Stiffness	3.52 ($\pm$ 2.34)	2.98 ($\pm$ 2.25)	0.62	.23
Thickness	1.79 ($\pm$ 1.33)	1.83 ($\pm$ 1.59)	0.86	.80
Irregular	4.19 ($\pm$ 2.68)	3.68 ($\pm$ 2.90)	0.62	.17
Sum of POSAS	16.17 ($\pm$ 7.33)	15.15 ($\pm$ 8.83)	0.41	.05
Overall score	3.74 ($\pm$ 2.27)	3.38 ($\pm$ 2.85)	0.64	.32

Components at 6 mo	Mean ($\pm$ SD)		FDR	Raw <i>P</i> value
	Everted	Planar		
Pain	1.28 ($\pm$ 1.22)	1.35 ($\pm$ 1.29)	0.84	.37
Itching	1.54 ($\pm$ 1.65)	1.26 ($\pm$ 1.09)	0.84	.22
Color	3.35 ($\pm$ 2.39)	3.35 ($\pm$ 2.19)	1	1
Stiffness	2 ($\pm$ 1.31)	2.26 ($\pm$ 1.76)	0.84	.15
Thickness	1.65 ($\pm$ 1.25)	1.53 ($\pm$ 1.12)	0.84	.43
Irregular	3.07 ($\pm$ 2.16)	3.05 ($\pm$ 2.19)	0.84	.52
Sum of POSAS	12.88 ($\pm$ 5.71)	12.79 ($\pm$ 6.38)	1	.90
Overall score	3.47 ($\pm$ 2.38)	3.02 ($\pm$ 2.15)	1	.83

FDR, False discovery rate; *POSAS*, Patient Observer Self-Assessment Scale.

Table IV

Results of height, depth, and width at 3 and 6 months; means ($\pm$ SD) and *P* values from the paired comparisons

Components at 3 mo	Mean ($\pm$ SD)		Wilcoxon <i>P</i> value	McNemar <i>P</i> value
	Everted	Planar		
Height	0.58 $\pm$ 1.25	0.35 $\pm$ 1.03	.139	.08
Depth	-0.02 $\pm$ 0.08	-0.02 $\pm$ 0.06	1	1
Width	1.40 $\pm$ 1.23	1.26 $\pm$ 0.87	.686	-

Components at 6 mo	Mean ($\pm$ SD)		Wilcoxon <i>P</i> value	McNemar <i>P</i> value
	Everted	Planar		
Height	0.19 $\pm$ 1.03	0.14 $\pm$ 0.45	.752	.683
Depth	-0.05 $\pm$ 0.20	-0.07 $\pm$ 0.25	.423	1
Width	1.35 $\pm$ 1.40	1.37 $\pm$ 1.02	.219	-