Adhesive Strips Versus Subcuticular Suture for Mediansternotomy Wound Closure

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ABSTRACT ***Background and Aim:*** **This prospective randomized study was undertaken to compare the use of the 3M™ Steri-Strip™ S Surgical Skin closure system with a running absorbable subcuticular suture technique for skin closure following a mediansternotomy for cardiac surgical procedures.** ***Methods:*** **Thirty-six patients undergoing a mediansternotomy for a cardiac surgical procedure were prospectively randomized to either Steri-Strip S or subcuticular suture for wound closure. The wounds were evaluated on postoperative days 7 and 21 for erythema, edema, pain, cosmesis, and the time taken to close the incision.** ***Results:*** **Skin closure with Steri-Strip S was faster (5.33 ± 1.32 minutes steri-strips vs. 6.07 ± 0.91 sutures; $p = 0.06$) and resulted in significantly less erythema and edema, but no difference in pain or cosmesis after seven days. Following 21 days, there was no difference in pain, edema, or cosmesis between the groups. However, patients receiving steri-strips continue to have less erythema.** ***Conclusions:*** **Both Steri-Strip S and absorbable sutures are effective techniques for skin closure following a mediansternotomy incision for cardiac surgical procedures. Steri-Strip S can decrease the amount of erythema, but results in no significant difference in pain, cosmesis, or edema compared to the traditional subcuticular wound closure technique.**
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Sternal wound infections (SWI) and wound-related issues are an important source of morbidity for patients undergoing cardiac surgical procedures. They are associated with significantly increased length of stay and contribute to increased hospital costs. The traditional method of skin closure following a mediansternotomy incision involves absorbable subcuticular sutures. This can result in a local inflammatory response, which leads to erythema, cellulitis, and superficial wound infections.[1,2] Skin closure techniques, which avoid the use of absorbable sutures, have the potential to minimize inflammation and edema, erythema, and the pain associated with this response.

In a previous study, examining wound healing of endoscopic saphenous vein sites following coronary artery bypass graft (CABG) surgery, we demonstrated that wounds closed using the 3M™ Steri-strip™ S Surgical Skin system resulted in significantly less erythema and edema, and improved cosmesis compared to the traditional skin closure using an absorbable running subcuticular suture technique.[3] The Steri-strip™ S Surgical Skin closure system consists of polyurethane pads and polymeric strips coated with a nonlatex pressure-sensitive, hypoallergenic skin adhesive. The combination of adhesive pads and filament straps results in maximum adhesiveness, allowing for easier skin approximation and minimizes the chance for wound dehiscence.

The beneficial effects of the Steri-strip™ S Surgical Skin closure system in a small endoscopic saphenous vein harvest incision encouraged us to investigate their use in larger mediansternotomy skin incisions. This study was, therefore, undertaken to determine whether the use of the Steri-Strip S closure system would result in superior wound healing in mediansternotomy incisions compared to the traditional running absorbable subcuticular suture technique.

MATERIALS AND METHODS

Thirty-six patients undergoing a mediansternotomy incision for a cardiac surgical procedure were enrolled

Conflict of Interest: Research funding for this study was provided from a grant by 3M HealthCare, St. Paul, MN, who also donated the Steri-Strip S Surgical Skin closures used in the study. The authors had full control of the design of the study, methods used, outcome measurements, analysis of data, and production of the written report.

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in this prospective randomized study. Approval was obtained from the Boston University Medical Center Institutional Review Board (Protocol number H-26298) and informed consent was obtained from each patient. In addition, the study was registered with the Clinical Trials.Gov (ID number NCT00576745).

Inclusion criteria included all patients undergoing a mediansternotomy incision for cardiac surgical procedures. Patients were excluded if they had diabetes mellitus, acute or chronic renal failure, or known keloid formers, required a period of circulatory arrest, had allergies to skin adhesives, required immunosuppressive medications or steroids, or had an underlying immunosuppressive disease.

All patients received a Phisohex scrub or shower the night prior to surgery, and received one gm of Cefazolin and one gm of Vancomycin intravenously (IV) 30 minutes prior to the incision. Subsequently, they received one gm IV of Cephazolin every eight hours and one gm of Vancomycin every 12 hours for 48 hours following surgery. Randomization was performed using a computer-generated blocked schedule. All incisions had the subcutaneous layer closed with a running 3–0 polyglactin (Vicryl, Ethicon, Inc., Somerville, NJ, USA) suture. In one group of patients, the skin was closed using the Steri-strip™ S Surgical Skin closure system (3M HealthCare, St. Paul, MN, USA) using an average of three packages of 100 mm, 3 1/8″ strips. The technique for applying these strips was previously described.[3] All of the investigators had undergone training in the application of this device. The suture group had the skin closed with a running 4–0 polyglactin suture (Vicryl, Ethicon, Inc.). Tissue adhesives were not used in either group. All incisions were covered with 4 × 4 gauze sponges and adhesive tape, which were removed after 48 hours. The strips were left in place for 7 to 10 days; after that time they sloughed off the skin.

All wounds were inspected daily. Parameters of wound healing were measured on postoperative days 7 and 21 by a nurse clinician. Primary end-points included ERYTHEMA (0 = none; 1 = barely perceptible minimal, faint; 2 = mild pink covering most, but not all, of the incision; 3 = moderate, pink-red, covering the entire incision; 4 = marked, bright red; 5 = severe, deep red); EDEMA (0 = none; 1 = slight, barely perceptible; 2 = mild, slight raising at the end of the wound; 3 = moderate, raised 1 mm from the edge of the wound; 4 = severe, raised greater than 1 mm and beyond the edge of the incision); PAIN (0 = none, 1 = barely noticeable; 2 = mild, slight irritation; 3 = moderate; 4 = severe); COSMESIS (0 = excellent; 1 = very satisfied; 2 = neutral; 3 = disappointed; 4 = unacceptable). In addition, the time taken to close the incision was assessed, as well as the incidence of deep or superficial wound infections, which were diagnosed based on the presence of a positive wound culture. A wound dehiscence was defined as the reopening of the incision greater than 0.5 cm in the absence of drainage or active infection.

An operative death was defined as a death from any etiology within 30 days of surgery. A perioperative myocardial infarction (MI) was diagnosed either by the appearance of new electrocardiographic (ECG) changes (Q-waves, ST segment elevation ≥1 mm; loss of R-wave in the precordial leads) or by the elevation of creatinine kinase MB levels ≥50 IU in the immediate 24-hour period after surgery. Time spent on the ventilator was recorded in hours from the time of admission to the Intensive Care Unit to the time of extubation. All patients were placed on standardized fast-track protocols for both extubation and hospital discharge. A cerebral vascular accident (CVA) was defined as any neurological deficit lasting ≥24 hours. Although patients with diabetes mellitus were excluded, glycemic control was observed in all patients by using IV insulin infusions to maintain serum glucose between 120 and 180 mg/dL.

Data are presented as the mean ± standard deviation. Two-sample t-tests were used to compare changes in scoring between days 7 and 21. Mean changes in each group for each parameter between days 7 and 21 were also calculated. A negative mean value indicated improvement in that parameter, while a positive mean value indicated a higher overall score. Results for all data points were considered significant when the p value was < 0.05.

RESULTS

The results are summarized in Tables 1–4. The types of operative procedures were similar in both groups (Table 1). The vast majority had CABG surgery with an internal mammary artery graft.

There were no 30-day operative mortalities (Table 2). One patient in the Steri-Strip S group developed a deep wound infection. This 58-year-old male was admitted with an 80% left main lesion, extensive three-vessel disease, and unstable angina. He had what was described as a gastrointestinal virus the week prior to admission. He underwent insertion of an intraaortic balloon pump and an urgent CABG × 4. His postoperative course was uneventful until the fourth postoperative day when he developed extensive drainage from the sternal wound and subsequently sternal instability. His

TABLE 1
Patient Profiles

	Suture	Steri-Strips
n	18	18
Male/Female	15/3	15/3
Age (years)	65.9 ± 3.4	67.3 ± 4.5
CABG	14	11
AVR	2	2
MVR	1	0
AVR + CABG	1	3
TVR	0	1
Left atrial myxoma	0	1
IMA harvest	15	14

Age values are mean ± standard deviation. CABG = coronary artery bypass graft; AVR = aortic valve replacement; MVR = mitral valve replacement; TVR = tricuspid valve replacement; IMA = internal mammary artery.

TABLE 2
Surgical Outcomes

	Steri-Strip	Suture
n	18	18
30 days mortality	0	0
Deep sternal infection	1	0
Superficial sternal infection	0	0
Wound dehiscence	0	0
MI	0	0
CVA	0	0
Ventilation > 24 hours	0	0
Hospital LOS (days)	8.3 ± 2.5	8.5 ± 1.9
Lost to Follow-up	0	0

Values are mean ± standard deviation for LOS.
MI = myocardial infarction; CVA = cerebral vascular accident; LOS = length of stay.

cultures grew out into an enterococcus organism and he underwent a sternal debridement and pectoralis major flap. He tolerated the procedure well and had an uncomplicated postoperative course. He was discharged on the 15th postoperative day with a six-week course of IV antibiotics. The infection was thought to be unrelated to the Steri-Strips. There were no superficial wound infections or dehiscences in either group. Furthermore, none of the patients experienced an MI, CVA, had prolonged ventilation, or were lost to follow-up. The type of wound closure had no effect on hospital length of stay (8.3 ± 2.5 days Steri-Strip S vs. 8.5 ± 1.9 days suture).

The time for skin closure tended to be faster for the Steri-Strip group, but this did not reach statistical significance (5.33 ± 1.32 minutes Steri-Strip S vs. 6.07 ± 0.91 suture; $p = 0.06$). After seven days, there was no difference in scores for pain or cosmesis between the groups (Table 3). Steri-Strip S patients had significantly less erythema (0.82 ± 0.39 vs. 1.44 ± 0.70; $p = 0.003$) and edema (0.53 ± 0.51 vs. 1.56 ± 0.78; $p < 0.001$) than patients with a suture closure. After 21 days, there was still no difference in pain or cosmesis between the groups. There was a significant decrease in edema (–1.11 ± 0.76 suture vs. –0.29 ± 0.47 Steri-Strip S; $p = 0.0006$; Table 4) in the suture group such that there was no longer any difference between the two groups. Patients receiving Steri-Strip S continue to have significantly less erythema than the suture group (0.41 ± 0.51 Steri-Strip S vs. 1.00 ± 0.77; $p = 0.01$; (Table 3).

TABLE 4
Changes in Pain, Erythema, Edema, and Cosmesis from Day 7 to Day 21

	Steri-Strip	Suture	p-value
Pain	–0.65 ± 0.61	–0.56 ± 0.78	0.70
Erythema	–0.41 ± 0.51	–0.44 ± 0.86	0.89
Edema	–0.29 ± 0.47	–1.11 ± 0.76	0.0006
Cosmesis	–0.47 ± 0.51	–0.39 ± 0.50	0.64

Patients closed with the suture technique required two 4–0 Vicryl sutures priced at $4.36 per patient. In contrast, three packets of Steri-Strip S were required for each closure priced at $32.91 per patient.

DISCUSSION

Steri-Strip S closures have been proposed as an alternative method for mediansternotomy wound closure because they can be applied rapidly, are inexpensive, painless, optimize cosmesis, and limit the chance of infection. This study sought to determine whether these potential advantages could be realized in clinical practice in a prospectively randomized study comparing Steri-Strip S to traditional subcuticular running absorbable sutures. While the Steri-Strip S technique is effective in achieving most of these goals, our study shows that they are not clearly superior to the traditional suture closure.

As in our previous study, and those of others, the time to closure was faster with the Steri-Strip S technique.[3–6] However, in our study, the mean difference was only 34 seconds and this did not reach statistical significance. There are several explanations for this. Two individuals closed the mediansternotomy incision using the suture technique starting at either end and meeting in the middle. Thus, the suture time may have been longer had only one individual closed the incision. The time to close using the Steri-Strip S technique (5.33 ± 1.32 minutes) was almost identical to the time recorded by van de Gevel (5.45 ± 3.35 minutes) in his series of CABG patients closed with the same Steri-Strip S technique.[7] The time for suture closure in that series was 7.53 ± 3.5 minutes compared to 6.07 ± 0.91 minutes in our series. At most, only two minutes was saved using the Steri-Strip S technique. Although operating time was saved, this does not account for the $28.55 increase in cost to use this

TABLE 3
Pain, Erythema, Edema, Cosmesis

	7 Days			21 Days		
	Steri-Strip	Suture	p-value	Steri-Strip	Suture	p-value
Pain	1.06 ± 0.83	1.22 ± 0.88	0.38	0.41 ± 0.62	0.67 ± 0.84	0.32
Erythema	0.82 ± 0.39	1.44 ± 0.70	0.003	0.41 ± 0.51	1.00 ± 0.77	0.01
Edema	0.53 ± 0.51	1.56 ± 0.78	<0.0001	0.24 ± 0.44	0.44 ± 0.62	0.26
Cosmesis	1.00 ± 0.06	1.22 ± 0.55	0.10	0.53 ± 0.51	0.83 ± 0.51	0.09

All values are Mean ± Standard Deviation.

particular brand of adhesive strips. When using the Steri-Strip S technique, additional time is spent insuring that the skin is dry and that there is no bleeding, and accurate apposition of the skin edges is achieved. Even when individuals have gained experience with this technique, this additional time is necessary to ensure that the strips will not separate prematurely. Similar to previous studies, we found that Steri-Strip S resulted in no difference in hospital length of stay[3,7] or the incidence of superficial wound infections.[3,4,7,8]

Changes in erythema and edema suggest that the Steri-Strip S technique had a favorable impact on reducing the inflammatory response. The degree of erythema was significantly less at both 7 and 21 days with the Steri-Strip S technique. This is consistent with previous studies comparing sutures with steri-strips.[3,9,10,11] However, the overall degree of erythema was minimal in both groups. While Steri-Strip S patients had significantly less edema at seven days, this advantage was lost when wounds were reexamined at 21 days when there was no difference between the two groups. From day 7 to day 21, there was a significant decrease in the amount of edema in the suture technique, as opposed to only a minimal change in Steri-Strip S patients. Thus, while the steri-strips may have resulted in less tissue damage and inflammation, this did not lead to a reduction in pain, infection, hospital stay, or cosmesis. Furthermore, the Steri-Strip S technique required that the patients pull off the strips at home, a maneuver that some patients felt uncomfortable performing.

In summary, our study showed that the 3M™ Steri-strip™ S Surgical Skin closure system is a safe and effective method for closing mediansternotomy incisions following cardiac surgical procedures. However, although there is evidence to support the concept that they reduce the inflammatory response associated with the suture technique, this did not affect clinical outcomes or hospital length of stay. In our study, we excluded patients with diabetes, inflammatory and immunosuppressive disorders, and those requiring steroids. It is conceivable that these patients may receive more benefit from the use of the Steri-Strip S technique and the avoidance of any inflammation seen with intradermal sutures. However, for the majority of patients with a mediansternotomy incision, closure with the Steri-Strip S technique does not result in clinical outcomes superior to those that can be achieved with traditional absorbable suture techniques.

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