Is barbed better? Evaluation of triclosan-coated barbed suture on wound complications following emergency laparotomy

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INTRODUCTION: Emergent laparotomy is associated with significant wound complications including surgical site infections (SSIs) and fascial dehiscence. Triclosan-coated barbed (TCB) suture for fascial closure has been shown to reduce local complications but primarily in elective settings. We sought to evaluate the effect of TCB emergency laparotomy fascial closure on major wound complications.

METHODS: Adult patients undergoing emergency laparotomy were prospectively evaluated over 1 year. Patients were grouped into TCB versus polydioxanone (PDS) for fascial closure. Subanalysis was performed on patients undergoing single-stage laparotomy. Primary outcomes were SSI and fascial dehiscence. Multivariate analysis identified independent factors associated with SSI and fascial dehiscence.

RESULTS: Of the 206 laparotomies, 73 (35%) were closed with TCB, and 133 (65%) were closed with PDS. Trauma was the reason for laparotomy in 73% of cases; damage-control laparotomy was performed in 27% of cases. The overall rate of SSI and fascial dehiscence was 18% and 10%, respectively. Operative strategy was similar between groups, including damage-control laparotomy, wound vac use, skin closure, and blood products. Surgical site infection events trended lower with TCB versus PDS closure (11% vs. 21%, $p = 0.07$), and fascial dehiscence was significantly lower with TCB versus PDS (4% vs. 14%, $p < 0.05$). Subanalysis of trauma and nontrauma cases showed no difference in SSI or fascial dehiscence. Multivariable analysis found that TCB decreased the likelihood of fascial dehiscence (odds ratio, 0.07; $p < 0.05$) following emergency laparotomy. Increased odds of fascial dehiscence were seen in damage-control laparotomy (odds ratio, 3.1; $p < 0.05$).

CONCLUSION: Emergency laparotomy fascial closure with TCB showed significantly decreased rates of fascial dehiscence compared with closure with PDS and a strong trend toward lower SSI events. Triclosan-coated barbed suture was independently associated with decreased fascial dehiscence rates after emergency laparotomy. (*J Trauma Acute Care Surg.* 2024;97: 149–157. Copyright © 2024 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/Care Management; Level III.

KEY WORDS: Barbed suture; dehiscence; fascia; laparotomy; trauma.

Emergency exploratory laparotomy is associated with significant risk for morbidity and mortality. Often, these complications are related to fascial dehiscence and surgical site infections (SSIs).[1–3] The presence of these factors can substantially increase risk for long-term complications, future incisional hernia, prolonged hospital stay, increased hospital costs, and mortality.[4–6] In fact, it is reported that up to 500,000 laparotomy-induced incisional hernias are seen annually in the United States and produce a significant burden of costs and morbidity even decades after the index laparotomy.[7]

While most published data are from elective cases, not every laparotomy has the luxury of a nonurgent status and preoperative planning and optimization. Emergency laparotomy is a high-risk procedure that may be associated with a 10% to 15% rate of fascial dehiscence and SSIs, but some report these compilations occurring as high as 45% of the time.[8] Thus, prevention of dehiscence and local infectious complications remains a topic of academic and clinical importance. Data from elective cases demonstrate the benefit of laparotomy closure using slowly absorbable monofilament suture in a continuous fashion with a 4:1 wound-length ratio.[7,9–11] Initial data in nontrauma emergency laparotomy seem to support a similar strategy.[8,12] However, the type of slowly absorbable monofilament suture may also have a significant impact, as triclosan-coated barbed (TCB) suture was recently evaluated for dehiscence and SSI prevention in emergency laparotomy patients.[13] In this prospective, randomized multicenter trial, Ruiz-Tovar et al.[13] found that TCB suture reduces the incidence of SSI and acute evisceration compared with standard fascial closure with triclosan-coated polydioxanone (PDS) looped suture and noncoated PDS looped suture in emergency nontrauma laparotomy.

Unfortunately, these reports have limitations, including the fact that they do not include trauma laparotomy, they have small sample sizes, and traumatic patient factors do not necessarily make the extrapolation across scenarios simple. In addition, most previous studies exclude patients with the presence of midline hernia, previous laparotomy, or previous dehiscence—all factors that may be present in trauma cases. In addition, traumatic laparotomy may be performed using a "damage-control" strategy that delays the final fascial closure. Damage-control scenarios are performed under less-than-ideal circumstances and may already be set up for less than stellar wound outcomes following closure, especially when as the timing to closure is prolonged.[14] The benefit of TCB suture in prevention of SSI and dehiscence in emergency laparotomy warrants further investigation of TCB in midline laparotomy closure following both nontrauma and trauma scenarios.

The aim of this investigation is to compare the use of TCB suture with conventional nonbarbed, PDS suture in the closure of abdominal fascia in patients undergoing emergent laparotomy for trauma or emergent general surgery conditions on local wound complications including fascial dehiscence and SSIs. Based upon previous data,[13] we hypothesize that rates of abdominal fascial dehiscence will be lower in laparotomies closed with TCB.

PATIENTS AND METHODS

After undergoing local institutional review board approval, a prospectively collected observational study was performed on patients undergoing emergent laparotomy at an American College

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of Surgeons Level 1 trauma center over a 1-year period using the appropriate STROBE guidelines for observational studies (Supplemental Digital Content, Supplementary Data 1, http://links.lww.com/TA/D718). Inclusion criteria included adult patients undergoing emergent midline laparotomy for either trauma or emergency general surgery with primary fascial closure during the same hospital admission. Patients were excluded if they were younger than 18 years, had a history of immunocompromise (determined by the presence of a documented immunodeficiency or immunosuppressive medication present at time of hospital admission), presented with a known nosocomial infection, or were deceased or lost to follow-up during the first 30 days following the index laparotomy.

The type of suture used was determined by the surgeon of record. Before the study, four surgeons were known to prioritize TCB in fascial closures. However, throughout the course of the collection period, all surgeons had experience with both TCB and PDS fascial closures. While not specifically recorded, the standard practice among the included surgeons is to close the facial wounds by using continuous 0.5 cm by 0.5 cm fascial bites in a 4:1 wound-length ratio. The standard group practice for fascial closure is to use either two no. 1 looped PDS suture in running fashion or two no. 1 TCB sutures (Stratafix; Ethicon Inc., Cincinnati, Ohio) on a CT or CT-1 needle in running fashion. The PDS sutures are run from each end of the incision and tied at the midpoint using at least seven knots. The TCB sutures are run from each end of the incision and then run for an additional two to three bites to overlap each other and lock the suture without the need for any knot tying. Patients were evaluated based upon the type of suture used at the initial fascial closure, TCB versus PDS.

Definitions

Incisional SSI's were defined according to the Centers for Disease Control criteria of the documented presence of at least one of the following features: purulent drainage, positive culture, pain, tenderness, redness, and swelling.[15] Superficial SSI was defined as a documented infection of the skin where the incision was made. Deep SSI was defined as documented evidence of the local muscle and/or surrounding tissues beneath the incision. Organ space SSI was defined as a documented infection in an area of the body other than skin, muscle, and surrounding tissue that was involved in the surgery.

Fascial dehiscence was defined as any documented evidence of fascial separation seen on physical examination or imaging. Evisceration was defined as any evidence of intra-abdominal contents protruding through the fascial defect seen on local examination or imaging.

Extracted clinical variables included demographic data (age, sex, body mass index [BMI], comorbidities, preoperative diagnosis, mechanism of injury, and Injury Severity Score), procedural data (operative procedures performed, presence of associated injuries, blood product utilization, damage-control laparotomy, temporary abdominal closure, and timing of facial closure [if not performed during index laparotomy]), and postoperative occurrences (superficial SSI, deep SSI, organ site infection, dehiscence, evisceration, fascial necrosis, need for unplanned abdominal reoperation, acute kidney injury, acute respiratory distress syndrome, bacteremia, sepsis, myocardial infarction, presence of postoperative steroids, presence of postoperative negative pressure wound therapy, need for prolonged [>7 days] postoperative antibiotics, and length of stay).

The primary outcome was fascial dehiscence. Secondary outcomes were SSIs and evisceration.

Statistical analysis was performed SPSS version 29 (IBM Corp., Chicago, IL) with statistical significance set at p value of <0.05. Continuous variables were reported as the median (interquartile range), and categorical variables were reported as n (%). Univariate analysis compared the parameters between study groups using Mann-Whitney U test for continuous variables and Pearson χ^2 or Fisher's exact test for categorical variables, as appropriate. Multivariable logistic regression was used to identify clinically relevant independent factors associated with a fascial dehiscence.

RESULTS

Two hundred ninety-eight patients underwent emergency laparotomy during the study time, 92 of which either died or were lost to follow-up before 30 days. Of the 206 patients meeting the inclusion criteria, 73 (35%) were closed with TCB, while 133 (65%) were closed with PDS. There were no differences in age, sex, BMI, or comorbidities between groups (Table 1). Trauma was the most common reason for laparotomy in both groups (TCB, 74% vs. PDS, 72%; $p = 0.782$). The majority of cases involved hollow viscus organs, with the small bowel being the most intervened-upon organ (46%). Rates of hollow viscus and solid organ injuries were similar across both groups.

Significantly fewer incisional events were seen in the TCB groups compared with the PDS group (13.5% vs. 25%, $p = 0.037$) (Fig. 1). Regarding local complications, SSI occurred in 19% of cases, with no difference seen between groups (11% vs. 21.1%, $p = 0.68$). Of these, rates of superficial SSI and deep SSI were also similar between the TCB and PDS groups. However, fascial dehiscence was less frequently seen in the TCB group (4.1% vs. 13.5%, $p = 0.032$). No difference was seen in systemic complications.

Secondary analysis was performed on patients separated by reason for laparotomy. The outcomes of laparotomy performed for trauma can be found in Table 2. Seventy percent of cases were performed for a penetrating mechanism, and damage-control laparotomy with temporary wound closure during the index laparotomy was performed in 35% of operations. The injuries were similar, with the exception of more colorectal procedures performed in the TCB group (51% vs. 33%, $p = 0.031$). Systemic complications were similar between groups. Despite the disparity in colorectal procedures, there was no appreciated difference in SSI or fascial dehiscence when the trauma laparotomy was closed with TCB versus PDS (13 vs. 22.9, $p = 0.138$; 10.4% vs. 3.7%, $p = 0.213$, respectively).

Fifty-six included laparotomy closures were performed for emergency general surgery indications (Table 2). Of these, more patients underwent a staged laparotomy with damage-control surgery in the TCB group (15.8% vs. 0%, $p < 0.05$). Despite this, no difference was seen in systemic or local complications between groups.

Since damage-control laparotomy was performed in 27.3% of all included laparotomies, secondary analysis was also performed on those patients (Table 3). The median day to definitive fascial closure was 2 days (interquartile range, 1–3 days), with

TABLE 1. Demographics and Outcomes Following Emergent Laparotomy Closed by TCB Versus PDS

Demographic	Total N = 206	TCB n = 73 (35.4%)	PDS n = 133 (64.6%)	*p*
Age	42 ± 1.2	48.7 ± 3.6	42.8 ± 2.9	0.771
Male	170 (82.5%)	61 (83.6%)	109 (82%)	0.771
BMI	28.1 ± 0.94	27.3 ± 0.86	27.8 ± 1.0	0.148
Comorbidities present	24 (11.7%)	8 (11%)	16 (12%)	0.819
Diabetes mellitus	16 (7.8%)	6 (8.2%)	10 (7.5%)	0.857
COPD	2 (1%)	1 (1.4%)	1 (0.8%)	1
Congestive heart failure	2 (1%)	1 (1.4%)	1 (0.8%)	1
CAD	2 (1%)	1 (1.4%)	1 (0.8%)	1
CKD	4 (1.9%)	1 (1.4%)	3 (2.3%)	1
Cirrhosis	5 (2.4%)	1 (1.4%)	4 (3%)	0.658
Preoperative steroid use	2 (1.0%)	1 (1.4%)	1 (0.8%)	1
Trauma	150 (72.8%)	54 (74%)	96 (72.2%)	0.782
Penetrating	105 (51%)	40 (54.8%)	65 (48.9%)	0.416
Blunt	45 (21.8%)	14 (19.2%)	31 (23.3%)	0.493
ISS				
>15				
>25				
Wound classification	3 [3–4]	3 [3–4]	3 [2–4]	0.614
>3	154 (74.8%)	58 (79.5%)	96 (72.2%)	0.250
Blood transfusions (preoperative)	41 (19.9%)	19 (26%)	22 (16.5%)	0.103
Blood transfusions (intraoperative)	32 (15.5%)	11 (15.1%)	21 (15.8%)	0.891
Blood transfusions (postoperative)	15 (7.3%)	8 (6%)	7 (9.6%)	0.345
Postoperative vasopressor use	37 (18%)	13 (17.8%)	24 (18%)	0.996
Postoperative steroid use	4 (1.9%)	0	4 (3%)	0.299
Surgical interventions				
Solid organ	49 (23.8%)	17 (23.3%)	32 (24.1%)	0.901
Liver	25 (12.1%)	10 (13.7%)	15 (11.3%)	0.611
Kidney	14 (6.8%)	4 (5.5%)	10 (7.5%)	0.774
Spleen	20 (9.7%)	11 (15.1%)	9 (6.8%)	0.054
Hollow viscus	155 (75.2%)	59 (80.8%)	96 (72.2%)	0.169
Colorectal	75 (36.4%)	33 (45.2%)	42 (31.6%)	0.052
Small bowel	94 (45.6%)	34 (46.6%)	60 (45.1%)	0.840
Stomach	28 (13.6%)	13 (17.8%)	15 (11.3%)	0.191
Bladder	11 (5.3%)	9 (6.8%)	2 (2.7%)	0.334
Vascular	19 (9.2%)	7 (9.6%)	12 (9%)	0.893
Damage-control laparotomy	56 (27.3%)	22 (30.1%)	34 (25.8%)	0.500
Fascial closure, d				
Skin closure	135 (65.5%)	45 (61.6%)	90 (67.7%)	0.384
Incisional wound vac	58 (28.2%)	22 (30.1%)	36 (27.1%)	0.639
Incisional events*	45 (21.5%)	10 (13.5%)	35 (25%)	0.037
Fascial complication	21 (10.2%)	3 (4.1%)	18 (13.5%)	0.032
Dehiscence	21 (10.2%)	3 (4.1%)	18 (13.5%)	0.032
Evisceration	3 (1.5%)	1 (1.4%)	2 (1.5%)	1
Necrosis	1 (0.5%)	0	1 (0.8%)	1
SSIs	36 (17.5%)	8 (11%)	28 (21.1%)	0.068
Superficial	15 (7.3%)	3 (4.1%)	12 (9%)	0.194
Deep	8 (3.9%)	3 (4.1%)	5 (3.8%)	1
Organ space	22 (10.7%)	5 (6.8%)	17 (12.8%)	0.187
Systemic complications	125 (7.7%)	78 (10.3%)	47 (5.5%)	0.433
AKI	26 (12.6%)	11 (15.1%)	15 (11.3%)	0.512
ARDS	2 (1.0%)	1 (1.4%)	1 (0.8%)	1
Bacteremia	14 (6.8%)	3 (4.1%)	11 (8.3%)	0.387
Sepsis	22 (10.7%)	4 (5.5%)	18 (13.5%)	0.073

*Defined as evisceration, fascial dehiscence, fascial necrosis, superficial SSI, and deep SSI.
AKI, acute kidney injury; ARDS, acute respiratory distress syndrome; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; ISS, Injury Severity Score.

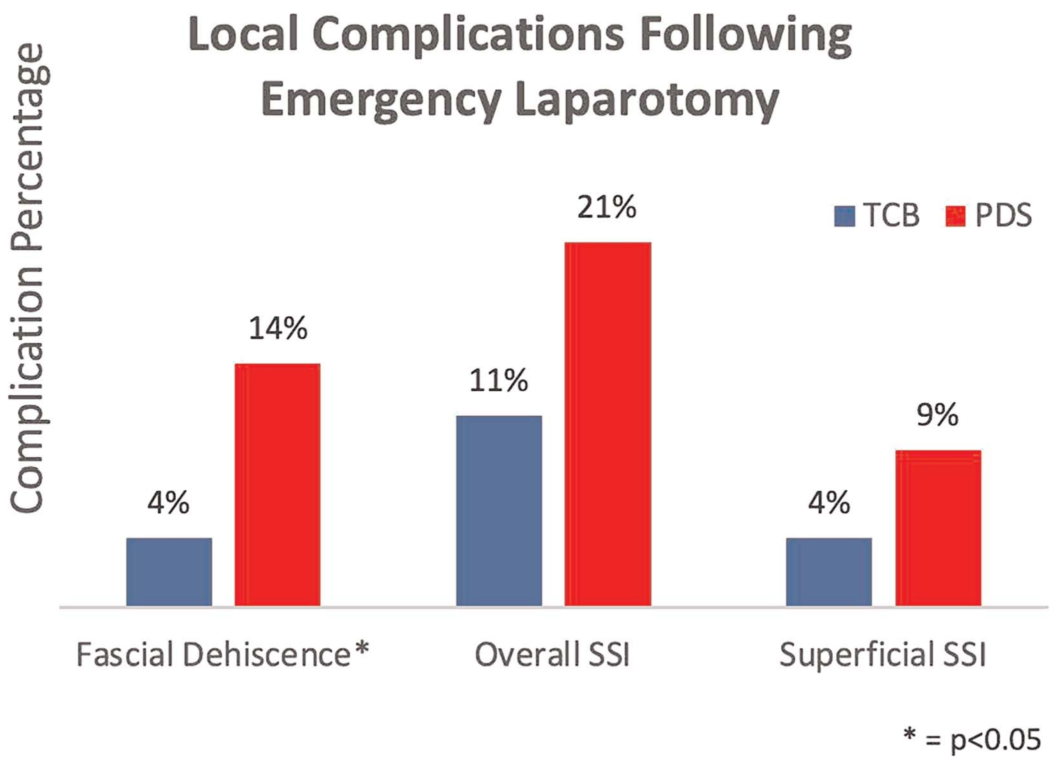

Figure 1. Rates of local complications following emergency laparotomy separated by fascial suture utilization.

time to closure being similar between groups. Regarding systemic complications, almost half of all patients developed some postoperative occurrence—the most common being acute kidney injury. However, the rates of total and individual systemic complications were similar in patient closed with TCB versus PDS. The rates of SSI and fascial dehiscence following definitive fascial closure after damage-control laparotomy were 12.5% and 16.1%, respectively. In a trend similar to that of systemic complications, the type of suture used for fascial closure following damage-control laparotomy was not associated with differences in local wound complications (Table 3). Subanalysis was also performed on fascial closures performed during the index laparotomy (Table 4) and on single-stage laparotomy with simultaneous skin closure (Table 5), with similar systemic and local outcomes seen between groups.

Multivariable logistic regression was performed to identify independent predictors of fascial dehiscence. After adjusting for sex, suture, wound class, and damage-control strategy, multivariable regression analysis, the type of suture used, and presence of damage-control laparotomy were independent factors associated with fascial dehiscence (Table 6; Fig. 2). Fascia closed following a damage-control laparotomy had increased odds of dehiscence (OR, 3.13; $p < 0.05$), whereas fascia closed with TCB had 75% decreased odds of developing postoperative dehiscence (OR, 0.25; $p < 0.05$)

DISCUSSION

To our knowledge, this is the first study to specifically evaluate the use of TCBs for midline abdominal fascial closure following both emergency general surgery and trauma surgery laparotomies. The study design was prospective observational and thus represents a "real-world" assessment of outcomes associated with the two studied approaches to fascial closure. The results of this study indicated that the use of TCB sutures reduces the odds of fascial dehiscence following emergency laparotomy and are consistent with results reported from elective surgery use of TCB and from the one available randomized trial in nontrauma patients.

Dehiscence is a known morbidity following laparotomy, with known associated risk factors. Some of these factors include emergency surgery and elevated BMI; the patients included in this analysis were already at a higher risk for dehiscence, as every case was performed in an emergent setting in patients with an average BMI of >28 kg/m^2.[16] The presence of SSI has also been shown to be a predictor of fascial dehiscence.[16,17] This study simultaneously evaluated the effect of TCB on dehiscence and SSI in high risk surgical patients.

The significant burden on hospital and patient-related outcomes associated with complications following laparotomy has led to strategies designed to prevent poor outcomes. While mesh placement can be used to treat postlaparotomy hernias, its prophylactic placement at the time of emergency laparotomy has been studied.[18] However, the placement of prophylactic mesh placement for emergency laparotomy has not been universally accepted despite some initial encouraging results; its routine use is not a current standard at out institution. In light of this, there has also been an influx in academic interest regarding how suture material affects incision closure outcomes. The suture used in laparotomy is often designed to be either slowly absorbable or permanent, thus allowing for a long potential exposure to bacterial presence, overgrowth, and biofilm development. If the suture

TABLE 2. Outcomes Following Laparotomy Closed With TCB Versus PDS

Demographic, n (%)	Trauma Total n = 150	TCB n = 54	PDS n = 96	p	Nontrauma Total n = 56	TCB n = 19	PDS n = 37	p
Penetrating	105 (70%)	50 (74.1%)	65 (67.7%)	0.414				
GSW	69 (46%)	27 (50%)	42 (43.8%)	0.461				
Wound class ≥3	115 (76.7%)	44 (83%)	71 (73%)	0.174	40 (68%)	14 (67%)	26 (69%)	0.890
ISS	16.9	17.1	16.8	0.691				
≥15	43.5%	44.8%	42.7%	0.791				
≥25	20%	20.9%	19.4%	0.814				
Surgical interventions					11 [3–15]	11 [3–15]	13 [3–15]	0.095
Solid organ	49 (32.7%)	16 (30%)	33 (34%)	0.632	1 (2%)	1 (5%)	0	0.356
Liver	25 (16.7%)	9 (17%)	16 (16.5%)	0.939	1 (2%)	1 (5%)	0	0.356
Kidney	14 (9.3%)	4 (7.5%)	10 (10%)	0.771	0	0	0	—
Spleen	20 (13.3%)	10 (19%)	10 (10%)	0.140	1 (2%)	1 (5%)	0	—
Hollow viscus	111 (74%)	43 (81%)	68 (70%)	0.141	44 (75%)	16 (76%)	28 (74%)	0.832
Colorectal	59 (39.3%)	27 (51%)	32 (33%)	**0.031**	16 (27%)	6 (29%)	10 (26%)	0.852
Small bowel	72 (48%)	27 (51%)	45 (46.4%)	0.594	22 (37%)	15 (40%)	7 (33%)	0.641
Stomach	19 (12.7%)	9 (17%)	10 (10%)	0.240	9 (15%)	4 (19%)	5 (13%)	0.708
Bladder	11 (7.3%)	2 (4%)	9 (9.3%)	0.329	0	0	0	—
Vascular	19 (12.7%)	7 (13.2%)	12 (12.4%)	0.883	0	0	0	—
Damage-control laparotomy	53 (35.3%)	19 (35.2%)	34 (35.4%)	0.977	3 (5.4%)	3 (15.8%)	0	0.035
Skin closure	96 (64%)	33 (61.1%)	63 (65.6%)	0.580	39 (69.6%)	12 (63.2%)	27 (73%)	0.449
Incisional wound vac	45 (30%)	17 (31.5%)	28 (29.2%)	0.766	13 (23.2%)	5 (26.3%)	8 (21.6%)	0.745
Incisional events	32 (21%)	8 (15%)	24 (25%)	0.168	13 (22%)	2 (9.5%)	11 (29%)	0.109
Fascial complication	12 (8%)	2 (3.7%)	10 (10.4%)	0.213	9 (16.1%)	1 (5.3%)	8 (21.6%)	0.146
Dehiscence	12 (8%)	2 (3.7%)	10 (10.4%)	0.213	9 (16.1%)	1 (5.3%)	8 (21.6%)	0.146
Evisceration	1 (0.7%)	0	1 (1%)	1	2 (3.6%)	1 (5.3%)	1 (2.7%)	1
Necrosis	1 (0.7%)	0	1 (1%)	1	0	0	0	—
SSIs	29 (19.3%)	7 (13%)	22 (22.9%)	0.138	7 (12.5%)	1 (5.3%)	6 (16.2%)	0.403
Superficial	11 (7.3%)	2 (3.7%)	9 (9.4%)	0.329	4 (7.1%)	1 (5.3%)	3 (8.1%)	1
Deep	7 (4.7%)	3 (5.6%)	4 (4.2%)	0.703	1 (1.8%)	0	1 (2.7%)	1
Organ space	18 (12%)	5 (9.3%)	13 (13.5%)	0.439	4 (7.1%)	0	4 (10.8%)	0.288
Systemic complications	39 (26%)	12 (22.6%)	27 (27.8%)	0.488	16 (28.6%)	7 (36.8%)	9 (24.3%)	0.326
AKI	18 (12%)	6 (11.1%)	12 (12.5%)	0.802	8 (14.3%)	5 (26.3%)	3 (8.1%)	0.105
Bacteremia	10 (6.7%)	2 (3.7%)	8 (8.3%)	0.331	1 (1.8%)	1 (5.3%)	0	0.339
Sepsis	16 (10.7%)	4 (7.4%)	12 (12.5%)	0.332	4 (7.1%)	1 (5.3%)	3 (8.1%)	1

AKI, acute kidney injury; ARDS, acute respiratory distress syndrome; GSW, gunshot wound; ISS, Injury Severity Score.

TABLE 3. Outcomes Following Damage-Control Laparotomy Closed With TCB Versus PDS

Outcomes	Total n = 56	TCB n = 22 (39.3%)	PDS n = 34 (60.7%)	p
Fascial closure, d	2 [1–3]	2 [1–3]	2 [1–3]	0.875
Incisional events	16 (28%)	3 (13.6%)	13 (37%)	0.055
Fascial complication	10 (17.9%)	2 (9.1%)	8 (21.6%)	0.146
Dehiscence	10 (17.9%)	2 (9.1%)	8 (23.5%)	0.285
Evisceration	0	0	0	—
SSIs	13 (22.8%)	2 (9.1%)	11 (31.4%)	0.050
Superficial	5 (8.9%)	1 (4.5%)	4 (11.8%)	0.638
Deep	4 (7.1%)	1 (4.5%)	3 (8.8%)	1
Organ space	8 (14.3%)	1 (4.5%)	7 (20.6%)	0.130
Systemic complications	27 (48.2%)	8 (36.4%)	19 (55.9%)	0.153
AKI	12 (21.4%)	4 (18.2%)	8 (23.5%)	0.746
Bacteremia	8 (14.3%)	2 (9.1%)	6 (17.6%)	0.460
Sepsis	10 (17.9%)	9 (26.5%)	1 (4.5%)	0.070

AKI, acute kidney injury; ARDS, acute respiratory distress syndrome.

TABLE 4. Outcomes Following Single-Stage Emergency Laparotomy Closed With TCB Versus PDS

Outcomes	Total n = 150	TCB n = 51 (34%)	PDS n = 99 (66%)	p
Incisional events	28 (18.5%)	7 (13.5%)	21 (21.2%)	0.244
Fascial complication	11 (7.3%)	1 (2%)	10 (10.1%)	0.099
Dehiscence	11 (7.3%)	1 (2%)	10 (10.1%)	0.099
Evisceration	3 (2%)	1 (2%)	2 (2%)	1
SSIs	23 (15.3%)	6 (11.8%)	17 (17.2%)	0.384
Superficial	10 (6.7%)	2 (3.9%)	8 (8.1%)	0.495
Deep	4 (2.7%)	2 (3.9%)	2 (2%)	0.605
Organ space	14 (9.3%)	4 (7.8%)	10 (10.1%)	0.773
Systemic complications	29 (19.3%)	12 (23.5%)	17 (17.2%)	0.350
AKI	14 (9.3%)	7 (13.7%)	7 (7.1%)	0.237
Bacteremia	6 (4%)	1 (2%)	5 (5.1%)	0.664
Sepsis	12 (8%)	3 (5.9%)	9 (9.1%)	0.752

AKI, acute kidney injury; ARDS, acute respiratory distress syndrome.

develops into a nidus for an infection, the risk for local wound complications, to include fascial dehiscence, is increased. One studied strategy to combat this is antiseptic coating of sutures, specifically with triclosan. The rationale behind triclosan-coated sutures in abdominal fascial closure is to prevent both translocation of intra-abdominal pathogens to the skin and bacterial adhesion to suture filaments.[19] A recent randomized controlled trial by Ruiz-Tovar et al.[13] found a significant decrease in SSI when using triclosan-coated sutures for fascial closure in emergency general surgery cases involving bowel resection with and without fecal peritonitis. Incisional wound closure with triclosan-coated suture is not novel, as multiple meta-analyses have been done regarding its effect on SSI.[18–20] There may be a contamination dose-limiting response, as most studies show a more pronounced benefit in nondirty cases. As the contamination increases, the benefit of a triclosan-coated suture may not be enough to be the primary factor in preventing SSI. Thus, a more obvious benefit may be seen in those cases where contamination is limited or controlled. This is a relevant factor affecting our study, as trauma laparotomy does not have the luxury of being limited to clean or clean-contaminated cases. The fact that almost 75% of cases in our study were classified as either contaminated or dirty may be associated with similar rates of SSI across groups; this represents a different patient population than previously reported in multiple studies.[20,21] However, the economic impact of triclosan-coated sutures may be more pronounced in those cases. Leaper et al.[22] found the financial and economic benefit of triclosan sutures more pronounced in dirtier wounds, with a $318 per-case reduction in sanitary costs in contaminated and dirty procedures. It is worth mentioning that the TCB group still had similar rates of SSI following trauma laparotomy despite undergoing more colorectal procedures. Colorectal procedures are known risk factors for SSI, and their increased prevalence in the TCB group may be a reason why no difference in SSI was seen in our trauma subanalysis.

TABLE 5. Outcomes Following Single-Stage Emergency Laparotomy With Simultaneous Skin Closure

Outcomes	Total n = 111	TCB n = 36 (32%)	PDS n = 75 (68%)	p
Incisional events	17 (15.3%)	6 (16.7%)	11 (14.7%)	0.784
Fascial complication	9 (8%)	2 (5.6%)	7 (9.3%)	0.424
Dehiscence	7 (6.3%)	1 (2.8%)	6 (8%)	0.424
Evisceration	2 (1.8%)	1 (2.8%)	1 (1.3%)	545
SSIs	12 (10.8%)	5 (13.5%)	7 (9.3%)	0.521
Superficial	5 (4.5%)	1 (2.8%)	4 (5.3%)	1
Deep	1 (0.9%)	1 (2.8%)	0	0.324
Organ space	7 (6.3%)	4 (11.1%)	3 (4%)	0.211
Systemic complications	17 (15.3%)	8 (22.2%)	9 (12%)	0.162
AKI	7 (6.3%)	4 (11.1%)	3 (4%)	0.211
Bacteremia	4 (3.6%)	0	4 (5.4%)	0.301
Sepsis	6 (5.4%)	2 (5.6%)	4 (5.3%)	1

AKI, acute kidney injury; ARDS, acute respiratory distress syndrome.

Barbed sutures have also gained academic interest regarding their safety and efficacy in tissue and/or fascial closure.[13] The benefits of barbed sutures are multifaceted, with previously published data on improving operative efficiency, hemostasis, and wound approximation.[22] One theory behind the benefit of barbed sutures is the equal distribution of tension across the wound,[13,23] whereas conventional sutures have highest tension but decreased strength around the knot.[24,25] In addition, barbed sutures may require more force before dehiscence occurs.[23,25] The self-locking barbs also may prevent the dehiscence from spreading, thus limiting evisceration events. Ruiz-Tovar and colleagues[13] argue this point, as they found fewer eviscerations with barbed sutures in their nontrauma emergency cases. However, the results of our study show that the benefit is not limited to evisceration prevention but also to dehiscence. Our results highlight the previously published benefit of barbed sutures, as dehiscence rates were improved even when SSIs were similar across groups.

Our results also echo similar findings, even in cases not associated with trauma.[8,12,13] Emergency laparotomy closed in a continuous fashion with slowly absorbable suture has decreased dehiscence,[8,12] with additional benefit seen when the suture is barbed.[13] However, as mentioned previously, a limitation to previous studies is the lack of trauma cases and the exclusion of cases with previous laparotomy. Our inclusion of fascial closure performed in a delayed fashion following damage-control laparotomy adds additional insight. The lack of benefit of TCB on both SSI and dehiscence in damage-control laparotomy closures may indicate that suture choice is not the main contributing factor of outcomes in those cases.[26,27] However, the included numbers were low, and a large evaluation is needed before that can definitely be stated.

There are several limitations to this study that warrant mention. Because this was an observational study, we did not dictate

TABLE 6. Multivariate Regression on Factors Associated With Fascial Dehiscence

Factor	OR	CI Low	CI High	p
Male	1.86	0.600	5.79	0.283
Damage-control laparotomy	3.13	1.21	8.11	0.019
TCB	0.25	0.068	0.877	0.031
Wound class ≥3	2.62	0.711	9.62	0.148

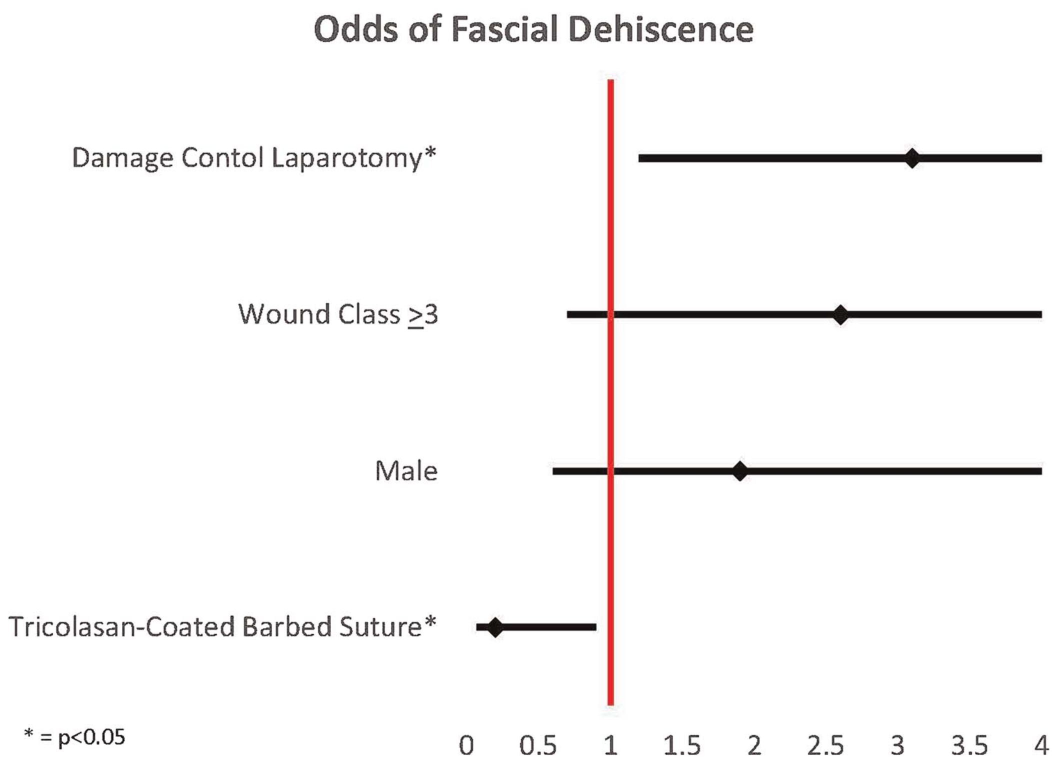

Figure 2. Independent factors associated with fascial dehiscence following emergency laparotomy.

the decision regarding suture choice or technique. Although there remains a common institutional practice, the fascial closure technique was not recorded. Thus, there is a possibility that some fascial closure in the PDS arm was performed in an interrupted fashion or with larger than typical fascial bites. Although routine CT imaging was not included as part of the diagnostic criteria for identifying fascial dehiscence, some occurrences were initially found on imaging. Thus, routine imaging could have theoretically identifying higher rates of dehiscence than reported here. In addition, the decision for damage-control laparotomy was not known. However, despite not knowing the reason for some of the initial operative decisions, it is unclear if this would have had much impact on fascial-related events. Also, there is the possibility of survival bias, as we only included patients who met the follow-up inclusion criteria. Given that the primary outcome was fascial dehiscence, long-term data were not captured. Thus, the rate of delayed incisional hernia is unknown and warrants further investigation. Future studies regarding broader use and comparisons with prophylactic mesh placement seem indicated.

CONCLUSION

The use of TCBs can potentially reduce the rate of fascial dehiscence and total incision-related complications following emergency laparotomy. Its use should be encouraged for both emergency and trauma laparotomy closure. Additional studies specifically evaluating TCB closure following damage-control laparotomy seem warranted.

AUTHORSHIP

J.D. contributed in the literature search, study design, data collection, data analysis, data interpretation, writing, and critical revision. P.M. contributed in the study design, data collection, data interpretation, writing, and critical revision. S.P. contributed in the data collection, data interpretation, writing, and critical revision. S.G. contributed in the data collection, data interpretation, writing, and critical revision. H.L. contributed in the study design, data collection, data interpretation, writing, and critical revision. K.M. contributed in the study design, writing, and critical revision. M.S. contributed in the study design, writing, and critical revision. K.I. contributed in the study design, writing, and critical revision. M.J.M. contributed in the literature search, study design, data collection, data analysis, data interpretation, writing, and critical revision.

DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/D719).

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