

Comparative Study of Use of Reusable Skin Staples and Vertical Mattress Sutures in the Closure of Midline Laparotomy Wounds

Abstract

Background: There is an increasing tendency to close midline abdominal wounds with staples because of the speed of closure. The aim of this study was to compare the use of skin staples and vertical mattress sutures in the closure of midline abdominal wounds. **Materials and Methods:** Patients who met inclusion criteria and were booked for laparotomy in our teaching hospital were counseled on the two methods of skin closure using vertical mattress sutures or the use of staples (35 W Surustap, Suru International PVT Ltd, India). Alternating post-laparotomy wounds were closed using skin staples and with a vertical mattress, using nylon 2(0) (3 metric) sutures. The parameters assessed were speed of closure, cost of closure using the different methods, wound infection rate, and short-term cosmetic appearance of wounds. Data were analyzed using SPSS version 21 (IBM, SPSS, Chicago, Illinois). **Results:** Sixty patients met the inclusion criteria and were recruited for the study. The speed of closure of midline laparotomy skin wound was significantly higher in “the staple group” than in “the suture group” (0.14 vs. 0.034 cm/s), $P < 0.05$, while the cost of use of staples was significantly more than the cost for closure with sutures (184 vs. 26 Naira/cm), $P < 0.05$. The mean operative time was significantly less in “the staple group” than in “the suture group” (128.9 minutes versus 157.6 min), $P < 0.05$. There was no significant difference in the infection rates and cosmetic appearance between the two groups ($P > 0.05$). **Conclusion:** Midline abdominal wound closure with staples is faster. There was no difference in wound complication rates and scar appearance when compared with skin closures using the vertical mattress technique. Wound closure with staples is, however, more costly.

Keywords: Midline abdominal wounds, staples, vertical mattress

Introduction

Wounds and their management are fundamental to the practice of surgery. The aim of wound closure is to promote rapid healing by apposition of wound edges and to leave a cosmetically acceptable scar. The technique should be tension-free, not watertight, and should be achieved without inverting the skin edges.^[1] Wound complication is the most important factor that influences patient satisfaction.^[2]

Skin closure of surgical incision is traditionally performed using sutures, skin staples, or adhesive tapes. Studies have shown no significant difference in the length of stay in the hospital, Hollander wound evaluation score, or patient satisfaction using sutures, skin staples, and tissue adhesives.^[3]

The development of mechanically satisfactory skin staples appears to represent an important advancement in closing long skin incisions.^[4] The efficiency and ease of placement of skin staples make them an attractive alternative to suture repair.^[5]

A variety of incisions provide exposure for most operations on the upper and lower abdomen/ pelvic organs.^[6,7] The optimal method of abdominal wound closure should be so technically simple that there will be no difference in the outcome in the hands of a trainee surgeon and an experienced surgeon. It should leave the patient with a reasonable aesthetic scar, and most importantly, it should minimize the frequency of wound rupture, incisional hernia, wound infection, and sinus formation.^[8]

The midline abdominal wall incisions can be closed in a single layer (mass closure),

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with a continuous suture with or without the peritoneum, or in multiple layers.

Mass closure involves suturing the entire abdominal wall layers (peritoneum, rectus sheath, and subcutis) in one piece, except the skin.^[9] This is usually done with a non-absorbable suture. Bites are taken about 1 cm from the margins of the cut edge and at intervals of approximately 1 cm, with continuous suturing using nylon 2 sutures.^[9] It can also be done with continuous interrupted suturing.

The practical value of any method of abdominal wound closure can be judged only when it is used in unselected patients by all surgeons who close abdominal wounds, irrespective of their degree of training.^[10] The use of either staples or sutures for skin reapproximation may have a significant impact on both patient safety and surgical outcomes.^[11]

Sutures and staples are applied by surgeons in the closure of many types of skin wounds. It is widely accepted that both sutures and staples can achieve the basic goals of wound closure.^[1] Newman *et al.*^[11] identified a significant increase in surgical wound complications when skin closure was undertaken with suture methods. No complications were noted when skin closure was achieved with staple closure.

Meiring *et al.*^[12] compared nylon sutures and staples, focusing on surgical time, and concluded that staples could save up to 80% of the time required for suturing with equal cosmetic results. Two comparative studies reported faster wound closure time with staple use but at the cost of wound inflammation, discomfort, and diminished cosmetic results in laparotomy and general wound closure.^[13,14]

In studies comparing sutures and staples, the average total cost per case was \$17.69 for the suture group and \$7.84 for the staple group ($P = 0.0001$). It was concluded that stapling is faster and less costly than suturing and that the advantage appears to increase as laceration length increases.^[15,16] This may not be applicable worldwide, though. Stapled wounds and those closed with sutures resulted in an equivalent cosmetic appearance of the scar.^[17]

The ability of the host to eradicate bacterial infection and prevent subsequent wound infection is affected by the presence of suture material in the subcutaneous tissues.^[18] In a prospective randomized controlled clinical trial in 341 abdominal operations, the overall wound infection rate in the sutured wounds was 17.0%, compared with 6.3% in those closed by clips ($\chi^2 = 9.26, P < 0.01$).^[18]

In another prospective randomized comparative study of sutures versus staples in skin closure of 66 hip surgery procedures, the only noted difference between techniques was better cosmesis with sutures.^[19] Singh *et al.*^[20] found significantly less wound discharge and redness with the use of sutures for wound closure after surgery for a fracture of the neck of the femur.

Graham *et al.*^[21] reported that staple use provided better blood perfusion to the wound site than sutures, which the authors correlated to improved conditions for wound healing. Contaminated wounds closed with staples have a lower incidence of infection than those closed with sutures. Staple closure also eliminates the risk of the surgeon getting a needle stick injury, which is an important consideration in trauma care for patients with unknown medical histories.^[22]

The advantages of the speed and convenience of skin staples outweigh the extra cost when the disposable instruments are reused until empty.^[23]

Materials and Methods

This study was hospital-based and carried out on an adult population. The study period was 1 year.

Included in the study were all new patients who gave consent and required laparotomy skin wound closure. We excluded all anemic, malnourished, and immune-suppressed patients. Anaemia was defined as hemoglobin (Hb) concentration less than 10 g/dl, while malnutrition was marked by albumin less than 28 g/dl. Diabetic patients and those with hematological disorders, as well as those on long-term steroids, were excluded. Also excluded were patients who have undergone previous surgeries for malignancies, those with low leucocyte and neutrophil count, as well as those with blood dyscrasias.

In this study, patients were followed up for 30 days. Wound complications beyond this time frame were not captured.

All consecutive new patients who met the inclusion criteria, gave informed consent, and required midline laparotomy skin wound closure in our hospital were enrolled. Ethical approval was obtained from the study center, with approval number NAUTH/CS/66/VOL.7/23.

Operations were categorized as to whether elective or emergency, and then each of the two was divided into dirty, contaminated, clean-contaminated, or clean. The patients in each category above were accordingly randomized into two groups of odd and even numbers by balloting [Figure 1]. Wounds of patients with odd research numbers were closed with staples, while patients with even research numbers had their wounds closed with sutures. The surgeries and wound closure were done by the principal investigator for control.

A dedicated research assistant did the categorization and balloting. The process of closure was timed in seconds by another dedicated assistant who was blinded to the method of wound closure. The length of the wound was measured in centimeters, and the number of staples or number of suture packs used was recorded by the investigator. Staples or sutures were placed approximately 2.0 cm apart. The effectiveness of closure was graded at operation and again on the 2nd, 8th, and 30th postoperative days.

Wounds were inspected on alternate days, starting from the 2nd day. Prophylactic antibiotics using intravenous third-generation cephalosporin and metronidazole were given at induction of anesthesia for both groups. In contaminated and dirty operations, full therapeutic antibiotic cover was continued for 5–10 days.

Wound infection is evidenced by redness, swelling, purulent exudates, and undue tenderness at the operation site, as well as systemic illness in the absence of other foci.

W-35 Surustap (Suru International PVT Ltd, India) staplers were used in this study. Each stapling device is preloaded with 35 staples. Reusable staples are cleaned with an enzymatic solution and sterilized by immersing in peraSafe solution for 60 min, with activity against viruses, mycobacteria, and fungi. It is, thereafter, thoroughly rinsed in sterile water and dried before use. Wound closure materials were generally removed at 8 days, and the ease or difficulty of removal was recorded. The cosmetic appearance was assessed at the removal of sutures/staples and on the 30th day.

The primary outcome measures were speed of closure, cost of materials used, and the development of complications in the wound, either as an in-patient (early) or within 30 days after discharge (short term). Secondary outcome measures included the length of stay, the cosmetic wound score, and patient satisfaction. A visual analog scale was used as a scar assessment tool.^[24] This assessment was done by a plastic surgeon, who was oblivious of the method of skin closure.

Results

Over the study period, a total of 357 new patients had both elective and emergency surgeries. Sixty patients who underwent elective and emergency laparotomies were randomized into two groups, as shown in Table 1. No death was recorded in the population studied, and none

was lost to follow-up. A male-to-female ratio was 1.14:1. The age of the patients ranged from 18 to 81 years, with a median age and mean age of 56.0 and 52.68 ± 16.33 years, respectively. The mean age of patients in the staple group was 52.97 ± 12.54 years, while the mean age of the patients in the suture group was 52.40 ± 19.62 years. The age categories of the study population showed that most patients were between 51.0 and 70.0 years. There was no significant difference in the mean age of participants, weight, height, body mass index, and hemoglobin level in both groups [Table 2].

Most of the indications for surgery were emergencies (58.33%), with the most common single indication for surgery being acute intestinal obstructions (25.0%).

The mean lengths of the wound for the staple group were 20.28 ± 2.12 and 20.08 ± 2.32 cm for the suture group [Table 3]. However, the mean operative time and skin closure with surgical staples were significantly faster than wound closure with sutures, as shown in [Table 4]. The cost of a surgical staple was \$11.67 (3501 Naira at 1 dollar for 300 Naira) for an average wound length of 20 cm, while each staple applicator costs \$5 1500 Naira at 1 dollar for 300 Naira). A total of 10 were used for the study. Two packs of nonabsorbable nylon sutures (Daflon) were used to close the same length of the wound at the cost of \$1.67 501 Naira at 1 dollar for 300 Naira).

A total of 23 patients had wound infections (12 for the staple group and 11 for the suture group). The wound infection rates between abdominal wounds closed with surgical staples and sutures showed no significant difference in infection rates between both methods of wound closure on days 4, 6, and 8. There was no evidence of infection in both wounds groups on day 2, and no additional wounds were infected by day 30. All the dirty wounds in both groups were infected by the 8th day. One clean wound was infected in the staple group [Table 5]. The total infection

Table 1: Distribution of patients based on the type of surgery and skin closure, gender, and diagnosis

Type of surgery	Group	Staples N (%)	Suture N (%)	Total N (%)
Emergency	Gender:			
	Female	6 (10)	5 (8.3)	11 (18.3)
Elective	Male	10 (16.7)	11 (18.4)	21 (35.1)
	Female	8 (13.3)	9 (15)	17 (28.3)
	Male	6 (10)	5 (8.3)	11 (18.3)
	Total	30 (50)	30 (50)	60 (100)
Emergency	Diagnosis:			
	Mechanical intestinal obstruction	7 (11.7)	7 (11.7)	14 (23.4)
	Perforated peptic ulcer diseases	5 (8.3)	5 (8.3)	10 (16.6)
Elective	Trauma	3 (5)	5 (8.3)	8 (13.3)
	Amoebic liver abscess	1 (1.7)	–	1 (1.7)
	Epigastric hernia	3 (5)	3 (5)	6 (10)
	Gall stone	2 (3.3)	2 (3.3)	4 (6.6)
	Incisional hernia	9 (15)	8 (13.4)	17 (28.4)
	Total	30 (50)	30 (50)	60 (100)

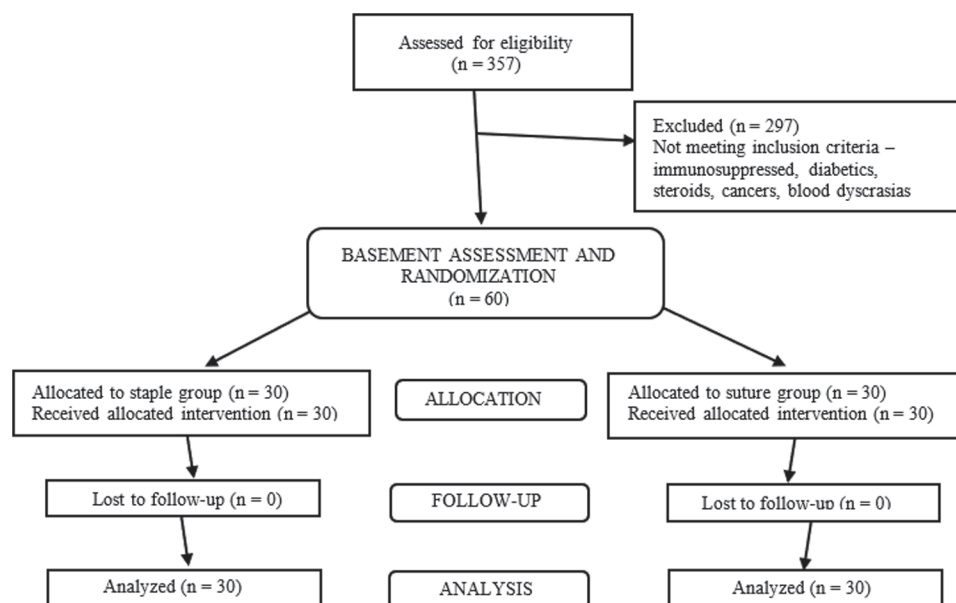


Figure 1: STARD flow diagram for participants

Table 2: Patient and wound characteristics

	Staples	Sutures	P value
	Mean (SD)	Mean (SD)	
Age	52.97 ± 12.54	52.40 ± 19.62	0.122
Hemoglobin level (g/dL)	10.20 ± 1.14	10.87 ± 1.56	0.312
Weight (kg)	63.17 ± 6.42	67.08 ± 7.44	0.457
Height (cm)	162.1 ± 6.19	162.69 ± 4.88	0.781
Body mass index (kg/m ²)	24.08 ± 2.43	25.32 ± 2.86	0.256
Length of wound (cm)	20.28 ± 2.12	20.08 ± 2.32	0.431

Table 3: Classification of wounds

Class of wound	Staples	Suture	Total
Clean	14	16	30
Clean contaminated	2	3	5
Contaminated	8	6	14
Dirty	6	5	11
Total	30	30	60

rate for each group, including all classes of wounds in this study, was 36.67%.

The cosmetic outcome of the patients showed that there was no significant difference between the mean rank of wounds closed with surgical staples and sutures using the visual analog scale, as illustrated in Table 6.

DISCUSSION

In this study, we compared the efficiency of the use of staple clips against the traditional use of sutures in closing midline laparotomy wounds, focusing on the speed of closure, cost of materials, complications, and cosmetic outcome.

The mean age for all subjects in this study was 52.68 ± 16.33 years, but the mean ages for the clips and suture groups were 52.97 ± 12.54 and 52.40 ± 19.62 years,

respectively. The age range of the subjects was 17–81 years. This age range was similar to the subjects studied by Khan *et al.*^[3] and Chandrashekar *et al.*^[25] and at variance with the population studied by Abdus-Salam *et al.*^[26] in Ibadan. The wide age range of subjects in this study reflects the wide distribution of abdominal surgeries across all age groups.

The two study groups were comparable in sociodemographic characteristics. In the study by Abdus-Salam *et al.*^[26] and Khan *et al.*,^[3] the sociodemographic features of the two groups were also similar.

The indications for abdominal surgeries include clean to dirty wounds, unlike in previous similar studies,^[26,27] where only clean wounds were studied. In the closure of abdominal wounds using sutures and clips by

Table 4: Parameters and cost on wound closure

Parameters	Skin	Closure	P value
	Staples	Suture	
	Mean ± SD	Mean ± SD	
Length of wound	20.28 ± 2.12	20.08 ± 2.32	0.729
Time of closure wound in seconds	164.80 ± 4.25	397.03 ± 28.38	0.003
Wound closure rate	0.14 ± 0.012	0.034 ± 0.01	0.001
Duration of surgery in minutes	128.9 ± 20.91	157.56 ± 18.05	0.049
Average day of suture/staple removal	10.00 ± 1.12	10.00 ± 1.5	0.832
Total length of wound closed in cm	721.5	706.0	0.67
Total time for wound closure in seconds	4920	11,911	0.04
Cost in Naira for 1 cm abdominal wound	183.67	26.30	0.01

Table 5: Wound infection

Infection	Staples	Sutures	X ²	P value
Day 2	Clean	–	–	–
	Clean contaminated	–		
	Contaminated	–		
Day 4	Dirty	–	0.023	0.765
	Clean	1		
	Clean contaminated	–		
	Contaminated	–		
Day 4 infection rate	Dirty	1	0.023	0.765
	Clean	1		
	Clean contaminated	1		
Day 6	Dirty	2	0.047	0.856
	Clean	–		
	Clean contaminated	–		
	Contaminated	2		
Day 6 infection rate	Dirty	2	0.047	0.856
	Clean	4		
	Clean contaminated	4		
Day 8	Dirty	2	0.084	0.961
	Clean	–		
	Clean contaminated	1		
	Contaminated	2		
Day 8 infection rate	Dirty	3	0.073	0.787
	Clean	6		
	Clean contaminated	4		
Total of infected wound	12	11	0.073	0.787

Table 6: Cosmetic outcome of the abdominal wounds after removal of staples/sutures

		Mean rank for outcome	Mean rank for outcome	U*	P value
		Staple	Suture		
Cosmetic outcome at removal	Elective	22.75	18.00	76.00	0.121
	Emergency	15.54	12.77	41.5	0.255
Cosmetic outcome on Day 30	Elective	22.16	19.50	85	0.231
	Emergency	16.54	13.50	27.5	0.412
Ease of removal (pain level)		43.68	17.32	54.50	0.001

U* = Mann–Whitney T-test

Abdus-Salam *et al.*,^[26] the subjects in both groups were overweight because of the pregnancy.

The mean operation time and skin closure time were observed to be significantly shorter in the surgical clip group compared to the suture group. This is consistent with the results of other studies.^[3,25,28,29] Thus, the use of surgical clips will mean a shorter duration of surgery and anesthesia for patients undergoing abdominal surgeries.

There was no significant difference in the wound complication rate on the 2nd, 4th, 6th, and 8th day and on the 30th day between the two groups. However, there was a case of an infected clean wound in a participant in the surgical clip group with seroma formation. A similar experience was also recorded by Abdus-Salam *et al.*^[30] The clean wound infection rates in this study of 14 patients are comparable with findings of other studies with clean wound complication rates of 1%–5%.^[31,32] None of the patients

in both groups had abdominal wound dehiscence, as we excluded all patients with predisposing comorbidities. We ensured proper patient selection, antibiotic prophylaxis, and application of basic surgical principles. Earlier studies suggested that the incidence of wound infection might be reduced with staples.^[33,34] This was based on the principle that the presence of a foreign material might compromise the host immune response. Furthermore, Pickford *et al.*^[34] suggested that as staples do not penetrate the incision but cross the incision site, this might prevent the introduction of foreign matters into the surgical wound. Graham *et al.*^[21] reported more favorable blood perfusion characteristics in wounds closed with staples rather than sutures. However, the index study did not reveal any advantage of clips over sutures when the wound infection rates were compared for both elective and emergency surgeries. In a study involving closure of abdominal wounds, infection was more common in the surgical clip group than in the suture group in elective wound closure and the converse in emergency wound closure.^[25] Some of the factors that may influence the wound infection rate was poor technique in staple placement, a common finding in surgeons who have little experience in the use of surgical clips.^[14,35]

The cost of the wound closure technique was significantly higher for the staple group compared to the suture group (184 vs. 26 Naira/cm of the wound), with attendant consequences on the patients who pay out of their pockets and may not be feasible for low-income-earning patients in settings like the study location.

There was also no difference in the participant's mean rank for assessment of cosmetic wound appearance in both study groups using the visual analog scale for scar assessment, as also observed in other studies.^[31,32] Furthermore, the index study also assessed patient's satisfaction based on pain during removal of the surgical clips and sutures. Removal of surgical clips was found to be significantly more discomforting than removal of sutures. This finding was in consonance with other studies.^[14,23] The relative discomfort of staple removal compared with suture removal has been reported previously in the literature.^[26,27] This is at variance with findings by Smith *et al.*^[29] who found out that the removal of sutures was more discomforting.

The time-saving benefits of staples might have a psychological effect on surgeons and theatre staff, particularly after a long operation, as they are better relaxed and prepared to take more cases.^[14,35,36]

Conclusion and Recommendation

Midline abdominal wound closure using staples is faster, with no difference in scar appearance and cosmesis, when compared with skin closures using the vertical mattress technique. The use of skin staples is more costly than the use of a vertical mattress for abdominal wound closure.

We recommend that a surgical skin stapler be used for patients who are at high anesthetic risk to reduce surgery time, as there is no difference in wound outcome. Skills for proper application of skin stapler should be acquired by both surgeons and trainees.

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Conflicts of interest

There are no conflicts of interest.

Inducement

None.

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