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KEY WORDS: skinsutures;skinstaplers;abdominalwoundclosure;surgicalsiteinfection;wound closure time; postoperative pain

A COMPARATIVE STUDY OF SKIN SUTURES AND SKIN STAPLERS FOR ABDOMINAL SURGICAL WOUND CLOSURE: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Skin closure following abdominal surgery influences wound healing, infection risk, patient comfort, and cosmetic outcome. Despite a growing body of comparative literature, optimal closure technique selection in resource-constrained, high-volume surgical environments remains undefined. This prospective observational study enrolled 100 patients undergoing elective or emergency abdominal surgery at Coimbatore Medical College and Hospital, India, between February 2024 and January 2025. Patients were allocated alternately to Group A (interrupted 3-0 monofilament nylon sutures, n = 50) or Group B (disposable skin stapler, n = 50). Primary outcome was wound closure time; secondary outcomes were postoperative wound complicationsandpainduringclosurematerialremovalassessedbyanumericratingscale (NRS0–10).Groups were demographically comparable in sex, age, and incision type distribution. All 50 stapler- group patients achieved closure in under five minutes, whereas no suture-group patient met this threshold; 30 suture patients (60%) required more than ten minutes (χ^2 = 42.857, p < 0.001). Postoperative complications occurred in 18 suture-group patients (36%) and 12 stapler-group patients (24%), a difference that was not statistically significant (χ^2 = 1.714, p = 0.19). Pain at removal was significantly lower in the stapler group, with 42 patients (84%) reporting NRS < 3 versus 20 patients (40%) in the suture group (χ^2 = 42.857, p < 0.001). Skin staplers confer statistically significant advantages in operative speed and patient comfort at closure material removal, with a safety profile equivalent to traditional sutures. These findings support selective use of staplers in abdominal wound closure, especially in emergency and high-volume surgical settings.

INTRODUCTION

Skin closure is the final and clinically consequential step in abdominal surgery, directly influencing wound healing, surgical site infection (SSI) rates, patient comfort, and cosmetic outcomes. The two most widely adopted closure techniques are traditional hand-placed sutures and mechanical skin staplers, each with a distinct profile of advantages and limitations.

Sutures have a documented history spanning millennia, from the Edwin Smith Papyrus (c. 3000 BCE) to the ancient Indian text *Sushruta Samhita* (c. 600 BCE).[1,2]Modern synthetic monofilament sutures, principally nylon and polypropylene, emerged in the mid-twentieth century and remain the global standard for skin closure owing to their low tissue reactivity, tensile strength, and cost-effectiveness.[3]Their principal limitation is application time :placing multipleinterrupted stitcheswithindividualknotswhich istime-intensive,particularlyfor longer incisions, and suture removal is associated with meaningful patient discomfort.[4]

Skin staplers entered routine clinical practice in the 1970s, deploying stainless steel or titanium staples that mechanically approximate wound edges within seconds.[5]Multiple studies and meta- analyses have demonstrated closure-time reductions of up to 50% relative to suturing, making staplersespeciallyattractiveinemergencylaparotomy,traumasurgery,andhigh-throughputelective practice.[6,7]However, their higher unit cost and the mandatory hardware-removal visit have limited universal adoption, particularly in resource-constrained settings.[8]

The existing comparative literature is predominantly derived from Western, obstetric, or orthopaedic surgical populations.[7,9]Data from Indian general surgical units, where case-mix, resource availability, and patient demographics differ substantially, remain sparse. Furthermore, most single-centre studies enroll patients undergoing a single incision type, limiting generalizability to the heterogeneous operative portfolio of a district general hospital. Thepresent study was therefore designed to compare skin sutures and staplers prospectively across multiple abdominal incision types within a tertiary referral centre in South India, evaluating closure time, wound complications, and pain at removal.

Methods

Studydesignandsetting

This prospective observational study was conducted in the Department of General Surgery, Coimbatore Medical College and Hospital (CMCH), Coimbatore, Tamil Nadu, India, from February 2024 to January 2025. Ethical approval was granted by the Institutional Human Ethics CommitteeofCMCH(ECReg. No.ECR/892/Inst/TN/2016;ApprovalNo.26/2024),andwritten informed consent was obtained from all participants prior to enrolment. The study was reported in accordance with the STROBE guidelines for observational research.

Participants

Patients of any age undergoing elective or emergency abdominal surgery at CMCH were considered for inclusion. Patients were excluded if they were undergoing repeat abdominal surgery or had pre-existing comorbidities that independently impair wound healing, specifically diabetes mellitus,pharmacologica limmunosuppression(including chroniccorticosteroiduse), or morbid obesity (body mass index > 40 kg/m²). These exclusions were applied to reduce heterogeneity in baseline healing trajectories and isolate the effect of closure technique.

Groupallocationand intervention

Onehundred eligible patientswere allocated alternatelyinthe order ofoperative listingtoGroup A (skin sutures, n = 50) or Group B (skin staplers, n = 50). Group A received wound closurewith interrupted 3-0 monofilament nylon sutures placed at approximately 1 cm intervals. Group B underwent closure with a single-use disposable skin stapler (stainless steel or titanium staples) fired at equivalent intervals. Fascial

closure (continuous slowly-absorbable polyglactin 910, No. 1)andsubcutaneousclosure(interruptedpolyglactin910,2-0,whenthesubcutaneouslayerwas≥ 2 cm thick) were standardised and identical across both groups. Perioperative antibiotic prophylaxis followed the institutional protocol and did not differ between groups.

Outcome

measuresTheprimaryoutcomewaswoundclosuretime,define dastheintervalinminutesfromplacement ofthefirst sutureor staple tocompletion ofskinclosure, recorded prospectively bytheoperating scrub nurse using a calibrated stopwatch. Secondary outcomes were: (i) postoperative wound complications — SSI (defined as purulent discharge or clinical diagnosis of wound infection within30days), wound dehiscence, seroma, and haematoma —assessedatpostoperative days 3, 7, and 30; and (ii) pain during removal of the closure material, recorded on a numeric ratingscale (NRS, 0 = no pain, 10 = worst imaginable pain) at the time of the outpatient removal visit. An NRS score < 3 was classified as low pain and ≥ 3 as moderate-to-severe pain.

Statisticalanalysis

DatawereenteredintoMicrosoftExcel2019andanalysedusingI BMSPSSStatisticsversion 22.0. Categorical variables were compared between groups using the Pearson Chi-square test. A p-value of < 0.05 was considered statistically significant. The sample of 100 was determined pragmatically by the twelve-month study period and available operative case volume.

RESULTS

Baselinecharacteristics

The demographic and operative profiles of both groups are summarised in Table 1. Groups were wellmatche dforsexdistribution(GroupA:29males,21females;GroupB:31 males,19females; p > 0.05) and age profile, with the 41–50-year stratum being the most frequently represented in both groups (16 patients each, 32%). Five incision types were represented across the cohort: McBurney (n = 42; the most common, constituting 42% of all cases), midline (n = 30), inguinal (n = 18), subcostal (n = 4), and paramedian (n = 6). The distribution of incision types was comparable between groups (all p > 0.05).

Table1.Baselinedemographicandoperativecharacteristicsofthestudygroups.

Characteristic GroupA–Sutures (n = 50)	GroupA–Sutures (n = 50)	GroupB–Staplers (n = 50)	p-value
Sex–Male,n (%)	29 (58)	31(62)	>0.05
Sex–Female,n(%)	21 (42)	19(38)	>0.05
Age range, years (most common stratum)	41–50(n=16)	41–50(n=16)	>0.05
McBurneyincision, n (%)	20 (40)	22(44)	>0.05
Midlineincision,n(%)	14 (28)	16(32)	>0.05
Inguinalincision,n(%)	10 (20)	8 (16)	>0.05
Subcostalincision,n (%)	2 (4)	2 (4)	>0.05
Paramedianincision,n(%)	4 (8)	2 (4)	>0.05
Abbreviations:n,numberofpatients.			

Primaryoutcome:woundclosuretime

Table 2. Represented the data regarding closure time. All 50 patients in Group B (100%) achieved wound closure in under five minutes; no patient in Group A achieved closure within this interval. In Group A, 20 patients (40%) required 5–10 minutes, 14 (28%) required 10–15 minutes, and 16 (32%) required more than 15 minutes. When dichotomised at the 10-minute threshold, 20 suture-group patients (40%) versus all 50 stapler-group patients (100%) achieved closurewithintenminutes,ahighlysignificantdifference(^{2}=42.857,p<0.001).Thesedataconfirm that mechanical stapling affords a consistent and substantial reduction in skin closure time across the spectrum of abdominal incision types included in this study.

Table2.Woundclosuretimebygroup.

ClosureTime	GroupA–Sutures,n (%)	GroupB–Staplers,n (%)	Total, n
<5min	0 (0)	50 (100)	50
5–10min	20 (40)	0 (0)	20
10–15min	14 (28)	0 (0)	14
>15min	16 (32)	0 (0)	16

^{2}=42.857,p< 0.001.NRS,numericratingscale.

Secondaryoutcome:postoperativewoundcomplications

Postoperative wound complications (Table 3.) were recorded in 18 suture-group patients (36%) and 12 stapler-group patients (24%). The most frequently observed complication in both groups was superficial SSI, followed by wound dehiscence; seroma and haematoma were infrequent. The 12-percentage point absolute difference in complication rates numerically favoured staplers;however,thisdidnotreach statisticalsignificance(^{2}=1.714,p=0.19),indicatingnosignificant difference in wound complication risk attributable to closure technique in this cohort.

Table3.Postoperativewoundcomplicationsbygroup.

Complication	GroupA–Sutures, n(%)	GroupB–Staplers, n(%)	p-value
Anycomplication	18(36)	12(24)	0.19
Nocomplication	32(64)	38(76)	—
^{2}statistic	1.714(notsignificant)		

^{2}=1.714,p=0.19(notsignificant).SSI,surgicalsiteinfection.

Secondaryoutcome:painatclosurematerialremoval

Pain scores at the time of suture or staple removal presented in Table 4. In Group B, 42 of 50 patients (84%) reported an NRS score < 3 (low pain) at staple removal, compared with 20 of 50 patients (40%) in Group A. Conversely, 30 suture-group patients (60%) experienced moderate- to-severepain (NRS ≥ 3), versus only 8stapler-group patients (16%). This difference was highly significant (^{2} = 42.857, p < 0.001), indicating that staple removal was substantially less painful than suture removal across this patient cohort.

Table4.Painscoreduringremovalofclosure material.

NRSPainScoreat Removal	GroupA–Sutures, n (%)	GroupB–Staplers, n (%)	p-value
<3(lowpain)	20(40)	42(84)	<0.001
≥3(moderate–high pain)	30(60)	8 (16)	<0.001

NRS,numericratingscale(0=nopain,10=worstimaginablepain). ^{2}=42.857,p<0.001.

DISCUSSION

This single-centre prospective observational study compared skin sutures and mechanicalstaplersforabdominal woundclosurein100consecutivelyenrolledpatientsacrossarangeofincision types. The key findings were: (i) stapler closure was dramatically faster, with every stapler-group patient completing closure in under five minutes; (ii) postoperative wound complication rates were comparable

between techniques; and (iii) patients in the stapler group experienced significantly less pain at the time of closure material removal.

The speed advantage of staplers corroborates the findings of Mehta et al. and Kanth et al., who independently reported that mechanical stapling reduces skin closure time relative to suturing by 30–50%, an advantage most pronounced for longer incisions.[4,10]In our cohort, the superiorityof staplers in closure speed was evident even for shorter McBurney incisions (median wound length < 5 cm), suggesting that the efficiency gain is not confined tomajor laparotomies. From a systems perspective, a consistent saving of 10–15 minutes per case translates into shortened anaesthetic exposure, improved operating theatre throughput, and reduced intraoperative fatigue for the surgical team which is relevant in high-volume public sector hospitals.[8]

The non-significant difference in postoperative complication rates (36% vs 24%; p = 0.19) is consistent with the broader comparative literature. Singh et al. and Anwar et al. both reported numerically, but not statistically, lower SSI rates with staplers in prospective cohorts of similar size. [1,9]The landmark meta-analysis by Paik et al. pooling data from eight randomised controlled trials in colorectal surgery found no significant difference in SSI rates betweenstaplers and sutures when perioperative antibiotic prophylaxis and subcutaneous closure were standardised — findings reflected in our results.[7] The numerically higher complication rate in thesuturegroupmaypartlyreflectthe longerwoundexposuretimeinherentinsuturingandthegreater number of needle passages through skin and subcutaneous tissue, each representing a potential point of microbial inoculation.[6]

The significantly lower pain scores in the stapler group at the time of hardware removal was a clinically important finding. Suture removal requires the identification and section of each individual knot, frequently involving cutaneous traction and, where sutures become partially embedded, more forceful manipulation. Staple removal, by contrast, was accomplished with a lever-action extractor that simultaneously deforms each staple back to its open configuration without skin traction. Khan et al. and Vaidya and Sharma et al. reported analogous results, attributing the patient comfort advantage of staplers to this mechanical difference. [5,13]Giventhat the outpatient removal visit represents an important patient-facing touchpoint in the postoperative pathway, minimising removal-related pain is likely to improve overall satisfaction and compliance with follow-up, both of which carry implications for timely detection of wound complications.

A distinctive feature of this study was the deliberate inclusion of five different incision types, reflecting the authentic operative case-mix of a district general surgical unit. This heterogeneity enhances external validity relative to single-procedure comparative studies but introduces variabilityin woundtension,length, and anatomical location thatmay have confounded outcome measurements. Kumar et al. noted that wound complications vary by incision type, with midline incisions at significantly higher risk of dehiscence; a larger study powered for incision-specific subgroup analysis would be a meaningful methodological extension of the present work.[11]From a health-economic standpoint, the unit cost of a disposable skin stapler exceeds that of a suture pack. However, this material-cost differential was potentially offset by savings in operating room time, which was among the most expensive resources in a hospital. Formal cost- effectiveness analyses incorporating the full cost of theatre time, anaesthetic personnel, and complication management are needed to determine the true economic impact of closuretechnique selection[8]

Several limitations warrant acknowledgement. Firstly, the allocation was alternating rather than concealed-randomised, introducing potential selection bias. The sample size of 100 was determined pragmatically and may be insufficient to detect small but clinically meaningful differences in complication rates, particularly for uncommon events such as dehiscence or haematoma. The identity and experience of the operating surgeon were not formally controlledas covariates, and variation in individual suturing speed may have widened the closure-time difference between groups. The long-term outcomes including incisional hernia formation and cosmetic scar assessment were both relevant to a complete comparison of these techniques but could notbe evaluated. Finally, the studywas conducted at a single centre with a specific patient demographic, limiting generalisability. Future adequately powered randomised controlled trials with concealed allocation, blinded outcome assessment, incision-type stratification, extended follow-up, and formal cost-effectiveness analysis are required to establish definitive evidence- based guidelines for abdominal skin closure technique selection.

CONCLUSION

This prospective observational study demonstrates that skin staplers offer statistically significant advantages over traditional interrupted sutures in two clinically important domains: wound closure speed and patient comfort at the time of closure material removal. Every stapler-grouppatientachievedclosurewithinfiveminutes,andthemajo rityexperiencedminimalpainatstaple removal. Postoperative wound complication rates, while numerically lower in the stapler group, did not differ significantly between the two techniques, affirming that both methods are safe for abdominal skin closure across a range of incision types.These findings support the selective use of skin staplers in abdominal surgery, particularly in settings where operative time is a premium, including emergency procedures, high-volume elective lists, and cases involving prolonged anaesthesia. Sutures retain relevance where cost constraints are paramount, precise tension adjustment is required, or where surgeon preference and training favour their use. Larger, well- powered randomised trials with incision-specific stratification, objective cosmetic scoring, and formal economic analysis are needed to establish definitive evidence-based guidelines for skin closure method selection in abdominal surgery.

Declarations

Ethical approval: Granted by the Institutional Human Ethics Committee, Coimbatore Medical College (EC Reg. No. ECR/892/Inst/TN/2016; Approval No. 26/2024).

Informed consent: Written informed consent was obtained from all participants prior to study enrolment.Conflictofinterest:Theauthorsdeclarenoconflictso f interest.

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Author contributions: A.A.M. conceived the study, collected data, performed statistical analysis, and drafted the manuscript. R.J. supervised the study, reviewed the data, and critically revised the manuscript. Both authors approved the final version.

Data availability: The master dataset supporting the findings of this study is available from the corresponding author on reasonable request.

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