

COMPARATIVE STUDY BETWEEN SKIN SUTURE VERSUS SKIN STAPLER IN ABDOMINAL SURGERY

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ABSTRACT

Background: An important part of the abdominal operation is closure of the wound. Whether to use skin sutures or skin staplers is still a matter of controversy. In this study, we reviewed the basic data performed at M H Lahore to evaluate these procedures.

Objectives: To compare the operative time, wound infection rate (SSI), cosmetic result (SBSE score), pain on removal, and cost between conventional sutures and skin staplers.

Methodology: A prospective observational study was conducted on 84 patients undergoing abdominal surgery at Lahore General Hospital. Patients were allocated to the Suture group (n=42) or Stapler group (n=42). Data were analyzed using SPSS, with chi-square and t-tests ($p < 0.05$ considered significant).

Results: The Stapler group had significantly faster skin closure times ($p < 0.001$). Cosmetic outcomes were markedly superior in the Stapler group, with 78.6% achieving a good SBSE score compared to only 45.2% in the Suture group ($p = 0.003$). Patients in the Suture group also reported significantly less pain during removal (73.8% had low pain scores) compared to the Stapler group (42.9%; $p = 0.008$). Surgical site infection rates were high in both groups, with no significant difference ($p > 0.05$).

Conclusions: Skin staplers significantly reduce operative time and provide vastly superior cosmetic results. However, contrary to some literature, this study found that suture removal is significantly less painful than staple removal. Surgeons should weigh these trade-offs – prioritizing staplers for cosmesis and time, and sutures for patient comfort during removal.

Key Words: Abdominal surgery, Skin stapler, Suturing, Wound closure, Surgical site infection, Cosmesis

1.INTRODUCTION

Abdominal surgery is one of the most frequently performed surgical procedures worldwide and is undertaken for a wide range of gastrointestinal,

hepatobiliary, urological, gynecological, and traumatic conditions. Postoperative wound infection remains a significant problem despite dramatic improvements in surgical technique,

anesthesia, perioperative management, and infection control. Because of its impact on wound healing, surgical site infection (SSI), postoperative pain, cosmetic outcome, length of hospital stay, and patient satisfaction, correct skin closure represents the final and one of the most important stages of any operation. Consequently, the choice of skin closure technique is a vital factor for the success of surgery. [Singh et al., 2023; Muthukumar et al., 2017]

Wound closure has a long history. Ancient peoples used a range of natural materials to suture wounds, horsetraw, linen thread, needle and thread made from animal sinews and silk, spider webs, and even adhesive paste made from figs. One of the earliest accounts of surgical wound closure appears in the Sushruta Samhita (about 600 BC), in which Sushruta detailed a number of needles and suture substances for tissue approximation. Over time, advances in surgical science enabled the introduction of absorbable and nonabsorbable sewings, tissue adhesives, adhesive strips, metal clips, mechanical skin staplers and more, all formulated to optimize wound healing while limiting adverse events. [Kathare et al., 2019; Singh et al., 2023]

The primary objective of skin closure is to restore the integrity of the skin while facilitating rapid healing and minimizing postoperative complications. Successful wound healing depends on several fundamental surgical principles, including meticulous tissue handling, preservation of tissue vascularity, accurate approximation of wound edges without excessive tension, adequate hemostasis, elimination of dead space, and strict adherence to aseptic techniques. The breach of these fundamentals can lead to infection, delayed wound healing, wound dehiscence, hypertrophic/scar formation and unsatisfactory cosmetic results. Therefore the quality of surgical approximation of skin is determined by the technique of the surgeon and the properties of the material used. [Singh et al., 2023; Varghese et al., 2017]

Healing of wounds is a biologically complicated process and proceeds through four overlapping phases, hemostasis, inflammation, proliferation, and remodeling. Blood clotting immediately

follows tissue injury to stop bleeding and acts as a temporary matrix for cell migration. The inflammatory phase is characterized by neutrophils and macrophages that clear microorganisms and necrotic tissue. Collagen is produced by fibroblasts, angiogenesis takes place, and re-epithelialization occurs during the proliferative stage. As for the remodeling phase, the scar is strengthened by collagen maturation and tissue reorganization. Healing may be impaired and there is an increased risk of wound complications postoperatively, if any of these phases are interrupted. So an accurate skin edge connection amid the complete wound mending period shows up a prerequisite to the accomplishment of great surgical comes about. [Singh et al., 2023; Vikraman et al., 2024]

For decades, conventional sutures have been the primary implies of skin closure in stomach surgery. Non absorbable sutures are broadly utilized like nylon and polypropylene which are having great ductile quality, lesser tissue response and more exact wound edge guess. Conventional suturing can be adjusted by the specialist between stitches concurring to the wounds highlights, its interesting in that respect when it comes to unpredictable wounds or those uncovered to solid pressure. Moreover, sutures are cheap, effectively open, and known to specialists allover the globe. In spite of the fact that suturing has customarily been respected as the gold standard for wound closure, it is related with a few pitfalls, counting being time devouring, more troublesome to perform, expanded tissue injury, and more noteworthy torment amid suture evacuation. [Muthukumar et al., 2017; Kathare et al., 2019]

Mechanical skin staplers were invented in response to the limitations and difficulties of traditional sutures. Modern disposable staplers are made of sterile stainless-steel staples and can rapidly approximate the skin edges with the least possible injury to the tissue. Since their initial introduction into clinical surgery, skin staplers have gained great popularity because they provide a convenient means of reducing wound closure time, enable easy uniform wound edge approximation, serve to minimize tissue

manipulation, and alleviate the surgeon's fatigue during extended procedures. Additionally, the limited tissue handling associated with stapling could help maintain local blood flow, diminish the inflammatory reaction and ultimately reduce postoperative wound morbidities. [Singh et al., 2023; Vikraman et al., 2024]

The well-known time saving in skin stapling was confirmed in the current study. Numerous studies have shown that stapling wounds is three to four times faster than the traditional method of interrupted suturing. Reduced closure time can not only reduce the amount of anesthesia exposure time, but also enhance the efficiency of operating room, contribute to the revenue productivity of hospital, and reduce the cost of health care investment. While the upfront cost of disposable staplers is higher than standard sutures, the savings in operative time may balance these additional costs, especially in high volume centers of surgical practice. [Kathare et al., 2019; Singh et al., 2023]

The cosmetic appearance of the postoperative scar has become a more and more crucial indicator of surgical quality. Not only do patients expect to have their illness treated successfully, but they also want minimal scarring and good aesthetic results. It has been postulated that skin staplers make finer scars as they cause less tissue crush and provide a more uniform wound edge apposition. On the other hand, similar or even better aesthetic results with traditional sutures have been shown in other studies, especially when the technique of suturing is careful and meticulous [5, 6, 21, 22]. These contradictory observations suggest that the cosmetic outcome is not determined by the type of closure material alone, but rather by several factors such as surgical technique, wound tension, anatomic site, patient related factors and postoperative wound care. [Varghese et al., 2017; Muthukumar et al., 2017]

Infection at the site of surgery is still a major cause of postoperative sepsis after abdominal surgery. SSI is a major factor in extended hospital stay, higher antibiotic use, additional surgical procedures, increased cost of care, delayed convalescence, and worse patient satisfaction.

Some patient-related factors, including diabetes mellitus, obesity, smoking, malnutrition, immunosuppression, and old age, predispose to infection. Procedure-related factors such as length of surgery, level of wound contamination, intraoperative tissue manipulation, method of skin closure also affect the incidence of SSI. As a result, a lot of effort has been dedicated to assessing whether the use of conventional sutures or skin staplers provide better protection against post operative wound infection. [Muthukumar et al., 2017; Varghese et al., 2017]

While skin staplers have found a lot of acceptance in contemporary surgical practice, the question of their superiority over traditional sutures persists without any consensus. Several randomized controlled trials (RCTs) and observational studies have evaluated and contrasted these two techniques for operating time, surgical site infection, wound healing, post-operative pain, patient satisfaction, cosmetic outcome, and cost-effectiveness in general. Although many authors have shown that staplers reduce wound closure time significantly and facilitate surgeons' convenience, some authors have found no significant difference in wound healing or cosmetic results. These contradictory results indicate that skin closure method should be chosen based on evidence, rather than preferring by surgeons. [Singh et al., 2023; Kathare et al., 2019]

Muthukumar et al. performed a randomized controlled trial of non-absorbable sutures versus skin staples for closure of the abdominal wound. Their results showed that stapler group had significantly lower rates of surgical site infection, less pain after staple removal, and higher satisfaction with cosmetic results than those who had traditional suturing. The authors also opined that the advantages associated with staplers were most striking in patients undergoing clean and clean contaminated abdominal procedure with long surgical wound. These results are in support of the increasing use of staplers as a safe and feasible alternative to conventional suture for closure in selected patients undergoing surgery. [Muthukumar et al., 2017]

Likewise, 100 patients undergoing elective abdominal surgery were assessed by Kathare et al. and they found skin staplers took significantly less time to close the wound as compared to traditional suturing. Also, the stapler group showed better procedural acceptance, less pain on removal of staples, and a better cosmetic outcome in the follow-up. The cost of staplers was higher initially but the authors remarked that the time saved during operation and the enhanced patient satisfaction justified the use of staplers routinely in certain clinical situations. [Kathare et al., 2019]

In another prospective study, Singh et al. Skin staplers versus conventional suturing in elective and emergency abdominal surgery: A randomized controlled trial. They found that there were significantly fewer postoperative wound infections and improved scar appearance when skin was closed with staplers as compared to conventional sutures and that closure with staplers was significantly faster. The authors highlighted that meticulous surgical technique with or without adjunctive mechanical stapling can enhance wound healing and attenuate postoperative morbidity, thereby substantiating the growing utilization of staplers in abdominal surgical practice. [Singh et al., 2023]

לא כל העדויות המתפרסמות תומכות ביתרון של, לאור זאת סתימות. Varghese et al. showed that the rate of post-operative wound infection was significantly higher in patients who underwent closure of their abdominal wounds with staplers compared to traditional methods of suturing. In addition, cosmetic evaluation was in favour of the suture group even though time taken in closure of wound was significantly longer in that group. The authors state that despite delivered cosmetic results and lower rates of infection in their patient population conventional sutures complemented staplers in terms of reducing operative duration. These disparate results demonstrate the persistent uncertainty of the best technique (in terms closure instrument) to close the skin in abdominal surgery. [Varghese et al., 2017]

In recent times, Vikraman et al. conducted a comparison of staple approximation with

conventional skin suturing technique in elective and emergency surgeries. They concluded that staple closure reduced the operative time significantly and led to better wound healing, less postoperative pain, fewer wound complications and better patient satisfaction. The study advocated skin staplers as the choice for skin closure in view of the advantages along with the good clinical outcome. However, the authors did note that larger multicenter studies are warranted before broad guidelines can be issued. [Vikraman et al., 2024]

The present data thus provide conflicting evidence on the efficacy of skin staplers when compared with conventional sutures. These discrepancies may be explained by differences in study design, patient characteristics and sample size, type of abdominal surgery, contamination of the wound, experience of the surgeon, postoperative care and methods used to assess outcomes. Some studies support staplers based on their speedy application and decrease in infection rates while others recommend sutures for their lower cost and better cosmetic outcome. Thus, the evidence to date is insufficient and further studies conducted in different centres are warranted. [Singh et al., 2023; Varghese et al., 2017; Muthukumar et al., 2017]

In countries like Pakistan, workload in general surgical units is largely taken up by abdominal surgeries. With limited resources, large patient turnover, and growing fears of postoperative surgical site infections, there is a need to find wound closure methods that provide clinical effectiveness together with feasibility and cost-effectiveness. Although both sutures and skin staplers are frequently used, there are few local studies comparing their outcomes in abdominal surgery in a full manner. Hence, it is imperative that locally generated evidence be available to inform clinical practice and improve patient care.

The "Comparative Study Between Skin Suture Versus Skin Stapler In Abdominal Surgery" observed skin suturing and skin stapling will be evaluated in terms of duration of operation, post operative wound infection, wound healing, cosmetic outcome and patient satisfaction. The

results of the study would provide the evidence to support surgeons in deciding the best method of skin closure which is clinically effective, safe, comfortable for patients and cost-effective. In the end, this work wants to bring better surgical outcomes and informed decisions-making in the abdominal surgery.

1.2 Problem Statement

Adequate closure of a surgical wound is one of the most crucial aspects of a surgical procedure. It determines the pace of wound healing, chances of wound infection, amount of pain after surgery, and also how visible the scar will be. When the wound edges are approximated precisely, healing tends to be quicker and less complicated.

For numerous a long time, surgical cuts have been closed with fastens (sutures). They are relied upon by specialists for their precision and steadfastness. Still, suturing can take longer and can cruel more tissue-handling. To overcome these impediments, surgical skin staplers were presented. Staplers empower wounds to be closed more quickly and are expecting to deliver small tissue response.

In show disdain toward of the break even with get to to both procedures, a noteworthy perplexity still exists as to which procedure confers the most excellent result in patients experiencing stomach surgery. Postoperative wound issues, patient satisfaction, cosmesis, and wellbeing care costs contrast between the options. In Pakistan, where get to to healthcare may be compelled by territorial aberrations and surgical inclination is high, determining the closure procedure that conveys the finest persistent result will have a far-reaching affect on understanding care and on healthcare framework.

The reason of this consider is to evaluate the viability and security of the customary sutures versus skin staplers in abdominal surgical wound [and] to analyze which can give superior clinical comes about and patient satisfaction within the application. Through the arrangement of evidence-based suggestions for the choice of the closure method, this work extraordinary to

contribute to the upgrade of surgical hone and understanding results in Stomach Surgery.

1.3 Rationale / Significance of Study

Adequate restoration of the skin barrier plays an important role in wound healing in abdominal surgery and has an impact on wound dehiscence, surgical site infection, operative time, cosmetic result, and patient gratification. Ordinary sutures, skin staples and cements have been utilized broadly, but there is still vulnerability with respect to which is more compelling. Here we compare the two approaches in terms of postoperative results, with the theory that one will be predominant to the other, hence giving assist prove to direct clinical decision-making and move forward the quality of surgical care.

2: REVIEW OF LITERATURE

Closure of the skin is the final arrange of each surgical intercession and is critical in reestablishing tissue boundaries, improving wound recuperating, dodging surgical location contaminations (SSIs), and giving ideal wound cosmesis. A great skin closure method should ensure adequate wound quality without causing over the top tissue injury and delays, coming about in a palatable scar. Numerous strategies and materials have been presented for closing skin wounds, but standard sutures and mechanical skin staplers still are the foremost common methods utilized in stomach surgery. Over the final 20 a long time there have been a number of distributions assessing these strategies to compare their relative preferences and impediments be that as it may the prove is clashing. [Singh et al., 2023; Varghese et al., 2017]

The determination of skin closure technique is affected by numerous factors counting sort of operation, wound defilement, patient s components, surgeons inclination and accessibility of healthcare offices. Routine sutures have long been considered the gold standard procedure due to unwavering quality and lower fetched, but the utilize of skin staplers is getting increasingly prevalent since of quick application and straightforward dealing with. The agents

turned their attention to comparing these strategies in terms of surgical time, postoperative wound contamination, wound mending, restorative comes about, quiet fulfillment, and cost-effectiveness. [Muthukumar et al., 2017; Kathare et al., 2019]

Customary suturing is still considered the standard strategy for skin closure in stomach surgery by most specialists around the world. In common, non-absorbable materials, e.g., nylon, polypropylene, or polyester, are favored for their high intrinsic malleable quality, they bring out small tissue response and have exceptionally great taking care of properties. Hindered sutures allow accurate wound estimation and permit for pressure to be separately balanced over the wound. These properties make it perfect for utilize with sullied wounds and sporadic entry points in which thorough tissue estimation is required. [Varghese et al., 2017]

Conventional suture too includes a number of downsides, in spite of its predominance. Suturing involves higher specialized request, draws out surgery and requires numerous needle passes through the skin, which may result in more trauma and aggravation to the tissue. In addition, patients as often as possible complain of torment and inconvenience when sutures are expelled and lasting fasten marks may contrarily influence cosmetic outcomes. These confinements drove specialists to consider unused wound closure procedures that may diminish agent time without compromising wound recuperating. [Kathare et al., 2019; Singh et al., 2023]

To facilitate skin closure, mechanical skin staplers were introduced. These devices feature sterile stainless-steel staples that approximate wound edges quickly and with minimal tissue manipulation. Instead of compressing tissues as sutures do, staples preserve local blood flow and tissue ischemia is diminished. Their speed of application reduces operating time, limits the fatigue of the surgeon during long procedures and offers a more consistent wound edge apposition. These benefits have led to their general acceptance in most surgical specialties such as general surgery, orthopedics, obstetrics,

and cardiothoracic surgery. [Singh et al., 2023; Vikraman et al., 2024]

Although the skin staplers have been reported to have some technical advantages, it is still a matter of debate that whether the cost is higher and the use of skin stapler would affect the incidence rate of postoperative wound infection and cosmetic appearance. Disposable suture staplers are much more expensive than traditional suture materials, which prevents them from being used routinely in many developing countries. Also, conflicting results have been reported in the literature concerning rates of infection and scar quality following staple closure. As a result, the question as to whether the speed of wound closure (at an additional cost associated with staplers) is worth the benefit, is still debated among surgeons. [Varghese et al., 2017; Muthukumar et al., 2017] A few clinical studies have contrasted the use of skin staplers with conventional suturing in terms of different outcomes. The most frequently evaluated variables are time to close the wound, postoperative pain, surgical site infection (SSI), wound dehiscence, cosmesis, patient satisfaction, days of hospital stay, and overall treatment cost. Although some authors found excellent results in terms of operative time, and patient comfort, with staplers, they were better or similar to those obtained with conventional suture. These discrepancies indicate that at present there is no ideal method for the approximation of skin following abdominal operation. [Singh et al., 2023; Kathare et al., 2019]

Reduction of wound closure time is one of the most consistently reported results in the literature concerning skin staplers. Rapid skin wound closure decreases anesthesia time and allows for improved operating room flow and surgical volume, especially at busy hospitals for healthcare. Yet the length of time for wound closure is but one facet of surgical quality. Long-term results such as wound infection, scar formation, and patient satisfaction are still essential in deciding the best skin closure method. Hence, the authors suggest that both short-term and long-term outcomes should be assessed prior to considering either approach as a

standard of care. [Vikraman et al. , 2024; Singh et al., 2023].

Varghese et al. (2017) Design: A prospective observational study Place of study: Department of General Surgery, Government Medical College, Kottayam, India Objectives: To compare abdominal wound closure with stainless steel skin staples and conventional non absorbable polyamide mattress sutures. There were 120 patients, 60 patients in each arm of stapler group and suture group. All the patients were given prophylactic antibiotics prior to surgery and were monitored for wound infection, inflammation, wound gaping and cosmetic result. The authors stated that wound closure time was significantly shorter using skin staplers than conventional sutures (4.55 ± 1.65 minutes versus 11.22 ± 4.45 minutes). However the rate of postoperative wound infection was higher in the stapler group (30%) than the suture group (11.7%), and cosmetic results were better among those patients who were sutured conventionally. Based on these findings the authors concluded that though the staplers increased operative efficiency, conventional sutures gave better cosmetic results and lesser rates of wound infection after abdominal surgery. [Varghese et al., 2017]

Muthukumar et al. (2017) conducted a randomized controlled study to evaluate skin staples versus conventional non-absorbable sutures in patients who had undergone abdominal surgery. The researchers evaluated wound closure time, postoperative pain, surgical site infection, wound healing, and patient satisfaction. Their findings showed that the use of skin staplers significantly reduced the duration of wound closure and the pain intensity on staple removal. In addition, fewer wound infections were observed in those patients with wounds closed with skin staplers, and the cosmetic result achieved a higher level of patients' satisfaction in the stapler group. The authors suggested skin stapler as an effective and safe alternative to traditional suture for closure of the abdominal wound especially in case of clean and clean-contaminated surgeries from evidence. [Muthukumar et al., 2017]

Kathare and colleagues (2019) evaluated skin staplers versus traditional sutures in patients having elective abdominal surgery: a prospective clinical trial. The investigators specifically considered operative time, incidence of postoperative wound complications, pain during removal, and cosmetic result. Their results demonstrated that staple closure took significantly less time than conventional suturing, leading to improved efficiency in the operating room. The satisfaction scores of patients treated with staples for removal were less pain and better overall cosmetic appearance of scar. Although the cost of material for the use of staplers was higher initially, the clinical benefits deriving from the decrease in operative time and better patient comfort during postoperative course were considered paramount. The authors stated that skin staplers are an effective substitute for conventional sutures in usual abdominal wound closure. [Kathare et al., 2019]

Singh et al. (2023) conducted a prospective comparative study to assess the staple approximation and skin suturing in an elective and emergency surgical procedure patients. Wound closure time, wound healing, postoperative infection, scar quality, and patient satisfaction were evaluated by the investigators. They found that skin staplers had a significant shorter closure time and facilitation of wound healing with minimal local inflammatory response when compared with conventional sutures. The cosmetic appearance of postoperative scars in the stapler group was also better. Patient satisfaction scores also were more positive for mechanical stapling because of less pain and earlier recovery. The authors commented that skin staplers offer an efficient technique for skin closure with certain benefits over traditional sutures in the right type of patient. [Singh et al., 2023]

Vikraman et al. (2024) a comparative cross-sectional designed study on those performed elective and emergency surgery who needs skin closure. They assessed staple closure versus conventional suture method in terms of wound closure time, postoperative wound healing, cosmesis, scar hypertrophy and patient

satisfaction. Their results showed that staple closure was superior in terms of operative time to traditional suturing, and achieved better patient satisfaction rate with comparable cosmetic results. They also observed minimal tissue reaction in “stapled eyes” and less inflammatory response compared to sutured. On the basis of these findings, they advocated increased use of skin staplers in the routine surgical practice, although they concede that other several multicenter studies are necessary to draw conclusive clinical standards. [Vikraman et al., 2024]

Some early studies have consistently reported among the best benefits of plastic skin staplers is the drastic reduction in time required for wound closure. Shortened skin closure time reduces the time spent under anesthesia, operating room turnover time, surgeon fatigue, and enhances overall surgical efficiency. These advantages are more pronounced in surgical centers where the daily number of cases is high. As a result, efficiency of the operation has become the most compelling argument in favor of the regular use of mechanical skin staplers in abdominal surgery. [Kathare et al., 2019; Singh et al., 2023; Vikraman et al., 2024]

Although these technical benefits, available evidence on postoperative wound infection is conflicting. To the contrary, Staple closure was associated with lower infection rates in the studies by Muthukumar et al. (2017) and Singh et al. (2023), although Varghese et al. (2017) found significantly increased wound infection in patients undergoing staple treatment. Differences in patient selection, wound contamination, surgical technique, perioperative antibiotic regimen, and postoperative wound management may explain these discordant results. Because of this, the present evidence is inadequate to confirm that either technique reduces the rate of surgical site infection in a sustained manner. [Varghese et al., 2017; Muthukumar et al., 2017; Singh et al., 2023]

The cosmetic results of skin closure are yet another option to consider in the evaluation of different skin closure methods. Patient expectations for scar appearance have risen dramatically in recent years, making assessment

of cosmesis an important outcome measure in surgical research. Several studies have reported better cosmetic result with skin staplers, attributed to the uniform wound edge approximation as compared to wound edges that become zigzag after with conventional suturing, other studies have reported that scar look better after precise conventional suturing. Such discrepancies imply that the quality of scar may be influenced not only by closure materials, but also by surgical techniques, wound tension, patient age, nutritional status, and post operative wound care. [Kathare et al., 2019; Varghese et al., 2017; Vikraman et al., 2024]

Thus, overall, the evidence from the literature suggests that both skin staples and traditional sutures have their advantages and disadvantages. Skin staples have been shown to consistently shorten wound closure time and increase operative efficiency, while traditional sutures are still considered affordable and in some cases, may even provide better or equal cosmetic outcome to that of staples. Similarly, post-operative wound infection shows a lack of consistency in the findings of the published reports. These discrepancies highlight a need for further well conducted comparative studies in different population to determine the optimal skin closure method for abdominal surgery.

3.1 Objectives

3.1.1 Broad Objective

To compare the clinical outcomes of conventional skin sutures versus skin staplers in abdominal surgical wound closure.

3.1.2 Specific Objectives

1. To study the total cost and operative time required for conventional sutures and staple repairs in abdominal surgical wounds.
2. To study the effect on wound healing and infection rate with the use of these techniques.
3. To study the cosmetic result of these two techniques.
4. To study the degree of patient satisfaction with these two techniques, including pain experience during removal.

3.2 Hypothesis

Null Hypothesis (H_0): When ends are everted, these sutures are more secure than others and when inverted they are less secure operative time, wound healing, infection rate, cosmetic result, and patient satisfaction are comparable for ordinary skin sutures and skin staplers in closure of abdominal surgical wounds.

Alternative Hypothesis (H_1): In case of abdominal surgical wound closure, traditional skin sutures and skin staplers differ significantly with respect to duration of operation, wound healing, rate of wound infection, cosmetic appearance and patient satisfaction.

3.3 Operational Definitions

1. Skin Sutures (Conventional Suturing): Suture (from the Latin word for seam) is a thread used to sew tissues together and close wounds. In the present study, by conventional suturing was meant the use of prolene 2-0 cutting body sutures with interrupted technique for closure of the abdominal skin.

Measurement: Duration of suture placement (min) and suture packets number

2. Skin Staplers: Stainless steel staples are applied with a mechanical instrument which brings the edges of the wound together quickly with little tissue manipulation. In this trial, the term skin staplers is reserved for the application of the Covidien staplers or equivalent disposable devices for closure of the abdominal skin.

Measurement: Duration for staple placement (min) and number of staplers used.

3. Wound Healing: The process of restoration of tissue regains its integrity after injury, including phases of hemostasis, inflammation, proliferation and remodeling. Healing of the wound was evaluated according to the Southampton Wound Assessment Scale.

Measurement: Southampton Wound Assessment Scale grades (Grade 0 = normal healing, Grade I = normal healing with mild bruising/erythema, Grade II = erythema + other signs of inflammation, Grade III = clear discharge, Grade IV = purulent discharge).

4. Surgical Site Infection (SSI): surgical wound infection: An infection that occurs within 30 days of surgery involving the skin or subcutaneous tissue of the incision site with or without pus coming from the wound, wound having positive culture or wound being opened by the surgeon due to infection.

Measurement: Clinical evaluation and culture findings; coded as yes or no for presence.

5. Cosmesis (Cosmetic Result): The width, height and color of the scar, the presence of suture or hatch marks and the general appearance of the surgical scar are taken into account in the evaluation of the aesthetic outcome.

Measurement: The Stony Brook Scar Evaluation System (SBSE) score; scores >3 were considered to have a good cosmetic result.

6. Patient Satisfaction: The extent of patient satisfaction with their wound closure experience, pain during closure and removal and overall comfort.

Measurement: Pain score during removal (categorized as <2 or >2 on a 10-point scale).

7. Operative Time (Time for Closure): Duration of skin wound closure after the end of deeper layer closure, calculated as the time from initiating skin apposition to the completion of wound closure.

Measurement: In minutes, categorized as <5, 5-10, 10-15, and >15 minutes.

8. Cost Analysis: The total cost of closure, including closure materials (sutures or staples) for the particular wound length.

Measurement: Pakistani Rupees (Rs.) for each closure technique, categorized by wound length (Group A: <5 cm, Group B: 5-10 cm, Group C: >10 cm).

4: MATERIAL AND METHODS

4.1 Study Design

Our study was a prospective comparative observational study done to evaluate the results of skin closure with traditional sutures versus skin staplers in abdominal surgery.

4.2 Study Setting

The study was carried out at the General Surgery Department, Mayo Hospital, Lahore, Pakistan. The patients were followed up during their hospital stay, and follow-up data were obtained through outpatient visits.

4.3 Study Duration

The duration of the research was four months (march 2026 to June 2026), following the approval of the synopsis.

4.4 Sample Size

A total of 84 patients were included in the study, with 42 patients in each group (Group A: conventional suture closure; Group B: skin stapler closure). The sample size was determined based on the feasibility of recruitment within the study period and the availability of resources.

4.5 Sampling Technique

A random sampling technique was employed. Patients were allocated to either group using a chit system, where patients were sequentially divided into two groups based on random selection before surgery.

4.6 Sample Selection

4.6.1 Inclusion Criteria

- Patients undergoing abdominal surgeries with clean and clean-contaminated wounds
- Patients undergoing both elective as well as emergency surgeries
- **Patients aged 18–60 years**
- Patients willing to participate in the study and provide informed consent

4.6.2 Exclusion Criteria

- Immunocompromised patients (malignancies, AIDS, uremia)
- Contaminated and dirty wounds
- Patients unwilling to participate in the study
- Patients with skin loss or traumatic wounds
- Patients with known allergy to suture/staple materials

4.7 Equipment

For Conventional Suture Group (Group A):

Prolene 2-0 cutting body sutures (Lotus); standard surgical instruments for suturing (needle holder, forceps, scissors).

For Skin Stapler Group (Group B):

Covidien skin stapler or equivalent disposable stapling device; staple remover for removal.

For Wound Assessment:

Southampton Wound Assessment Scale scoring sheet; Stony Brook Scar Evaluation System (SBSE) scoring sheet; Visual Analogue Scale for pain assessment.

4.8 Ethical Considerations

The following ethical considerations were strictly followed throughout the study:

1. **Institutional Approval:** Approval was obtained from the Institutional Review Board (IRB) of the University of Lahore and the hospital administration of Lahore General Hospital prior to data collection.
2. **Informed Consent:** A written informed consent was obtained from all participants (or their parents/guardians for minors) prior to their inclusion in the study.
3. **Confidentiality:** All patient information and data were treated as confidential. Data were kept on a password protected computer, and during data analysis patient identity was anonymized.
4. **Voluntary Participation:** Patients were informed that their participation was voluntary and that they were free to discontinue from the study at any time without any consequence or impact on their medical treatment.
5. **No Intervention:** We had no role in the design and conduct of the study. There was no intervention in this observational study; only routine care data were collected from patients according to standard hospital practice.
6. **Beneficence:** The research was done to enhance care and result for patients and were not subjected to any additional risks.

4.9 Data Collection Procedure

Data were collected prospectively from patients who were admitted to the surgical ward with the help of a structured data collection form specifically designed for this study. The procedure was as follows:

4.9.1 Pre-operative Phase

1. Presenting symptoms and associated comorbidities (such as diabetes mellitus, hypertension, and so on) were thoroughly recorded.
2. A thorough general physical examination was performed.
3. Routine tests were done: complete blood count (CBC), urine analysis, blood sugar, blood urea, serum creatinine, liver function tests, chest X-ray, and electrocardiogram (ECG) (if required).
4. Abdominal shaving or clipping was done prior to surgery.
5. All patients received a preoperative parenteral antibiotic 30–60 minutes before the surgical incision as per hospital protocol.

4.9.2 Intra-operative Phase

1. Patients were randomly allocated to either Group A (conventional suture) or Group B (skin stapler) using the chit system.
2. In Group A, wound closure was performed using Prolene 2-0 cutting body sutures with interrupted technique.
3. In Group B, wound closure was performed using Covidien skin staplers or equivalent disposable stapling devices.
4. The time taken for skin closure was recorded in minutes from the start of skin approximation to completion.
5. The length of the incision was measured and recorded.
6. The number of suture packets or staplers used was recorded.

4.9.3 Post-operative Phase

1. Patients were inspected on the 3rd postoperative day for wound assessment using the Southampton Wound Assessment Scale.

2. Patients were assessed on the 7th postoperative day and at the time of suture/staple removal (typically on the 10th postoperative day).
3. Wound complications, including infection, discharge, and gaping, were documented.
4. Pain during removal of sutures or staples was assessed using a pain score of <2 or >2 on a 10-point scale.
5. Follow-up assessment was conducted at 30 days post-surgery for evaluation of cosmetic outcomes using the Stony Brook Scar Evaluation System (SBSE).
6. Cost analysis was performed based on the materials used for each wound length category.

4.10 Data Analysis

4.10.1 Data Management

Data were entered into Microsoft Excel and then transferred to SPSS version 24 for statistical analysis.

4.10.2 Descriptive Statistics

Continuous variables (age, time for wound closure) were summarized using mean $\pm$ standard deviation (SD). Categorical variables (gender, type of incision, complications, etc.) were summarized as frequencies and percentages.

4.10.3 Inferential Statistics

Independent t-test was used to compare continuous variables (age, closure time) between the suture and staple groups.

Chi-square test was used to compare categorical outcomes (cosmetic outcomes, surgical site infections, pain scores) between the two groups.

Fisher's exact test was used where appropriate for small cell sizes.

4.10.4 Statistical Significance

A p-value < 0.05 was considered statistically significant. Results were presented with appropriate confidence intervals where applicable.

4.10.5 Software Used

Microsoft Excel 2019 for data entry and preliminary analysis; SPSS version 24 (IBM Corp., Armonk, N.Y., USA) for statistical analysis.

5. RESULTS

5.1 Study Population and Demographics.

5.1.1 Age Distribution

Age	Staples (n 42)	Sutures (n 42)
<20	1 (2.4%)	0 (0.0%)
21-30	7 (16.7%)	6 (14.3%)
31-40	17 (40.5%)	15 (35.7%)
41-50	14 (33.3%)	18 (42.9%)
51-60	3 (7.1%)	3 (7.1%)
Total	42 (100%)	42 (100%)

In the Staples group (n = 42), the highest proportion of patients belonged to the 31-40 years age group (17 patients; 40.5%), followed by the 41-50 years group (14 patients; 33.3%). The 21-30 years group included 7 patients (16.7%), while 3 patients (7.1%) were aged 51-60 years. Only 1 patient (2.4%) was younger than 20 years.

In the Sutures group (n = 42), the largest proportion of patients was in the 41-50 years age group (18 patients; 42.9%), followed by the 31-40 years group (15 patients; 35.7%). The 21-30 years age group comprised 6 patients (14.3%), and 3 patients (7.1%) were aged 51-60 years. There were no patients below 20 years in the Sutures group.

5.1.2 Gender Distribution

The gender distribution of the study participants is shown in Table 1.

Table 1: Gender Distribution of Study Participants

Gender	Stapler Group (n=42)	Suture Group (n=42)
Male	19 (45.2%)	21 (50.0%)
Female	23 (54.8%)	21 (50.0%)
Total	42 (100%)	42 (100%)

In the Stapler group, there was a slight female predominance (54.8%), while in the Suture group the split was exactly even (50.0% male, 50.0% female). This difference was not statistically significant ($p = 0.827$), indicating the groups were comparable in terms of gender distribution.

5.2 Time Required for Skin Closure (Primary Outcome)

Closure time was recorded using coded time-category bands (1: <5 minutes, 2: 5-10 minutes, 3: 10-15 minutes, 4: >15 minutes). The distribution across both groups is shown in Table 2.

Table 2: Time Required for Skin Closure

Time Category	Stapler Group (n=42)	Suture Group (n=42)
< 5 minutes	42 (100%)	3 (7.1%)
5 - 10 minutes	0	11 (26.2%)
10 - 15 minutes	0	24 (57.1%)
> 15 minutes	0	4 (9.5%)

The duration of skin closure was markedly shorter in the stapler group compared with the

suture group. All patients in the stapler group (42, 100%) had wound closure completed in less

than 5 minutes. In contrast, only 3 patients (7.1%) in the suture group required less than 5 minutes for skin closure. The majority of patients in the suture group required 10–15 minutes (24 patients, 57.1%), followed by 5–10 minutes (11 patients, 26.2%), while 4 patients (9.5%) required more than 15 minutes for wound closure. The result showed that the use of skin stapler for skin closure can shorten the time required for wound closure with the

conventional suture, which would enhance the operative efficiency, and may also lead to shortening of the total operation time.

5.3 Surgical Site Infection (SSI) and Post-Operative Complications

Wound assessment outcomes were coded as 1 (Normal healing), 2 (Clear discharge), and 3 (Purulent discharge). The distribution of outcomes in both groups is shown in Table 3.

Table 3: Wound Assessment Outcome (Surgical Site Infection)

Outcome	Stapler Group (n=42)	Suture Group (n=42)
Clear Discharge	5 (11.9%)	6 (14.3%)
Purulent Discharge	4 (9.5%)	5 (11.9%)
Normal healing	33 (78.6%)	31 (73.8%)
Total Complications (Clear + Purulent)	9 (22.4%)	11 (26.2%)

Combining clear and purulent discharge as “total complications,” 9 of 42 patients (22.4 %) in the Stapler group and 11 of 42 patients (26.2 %) in the Suture group showed some degree of wound complication. The chi-square test showed no statistically significant difference between the two groups regarding SSI rates ($p = 0.876$). Both

techniques were associated with a high rate of wound complications in this cohort.

5.4 Cosmetic Outcome (SBSE Score)

Cosmetic outcome was coded as 1 (Average/Poor) or 2 (Good) using the Stony Brook Scar Evaluation System. Results are shown in Table 4.

Table 4: Cosmetic Outcome (SBSE Score)

SBSE Score	Stapler Group (n=42)	Suture Group (n=42)
Average / Poor	9 (21.4%)	23 (54.8%)
Good	33 (78.6%)	19 (45.2%)

A “Good” cosmetic outcome was achieved in 78.6% of the Stapler group compared to only 45.2% of the Suture group. This difference was statistically significant ($p = 0.003$). Skin staplers provided superior cosmetic scar outcomes compared to sutures in this study.

5.5 Pain During Removal

Pain during removal was coded as 1 (Low pain, <2) or 2 (High pain, >2). Results are shown in Table 5.

Table 5: Pain Score During Removal

Pain Score	Stapler Group (n=42)	Suture Group (n=42)
Low Pain (<2)	18 (42.9%)	31 (73.8%)
High Pain (>2)	24 (57.1%)	11 (26.2%)

Only 42.9% of patients in the Stapler group reported low pain scores during removal, compared to 73.8% in the Suture group. This difference was statistically significant ($p = 0.008$).

Patients in the Suture group experienced significantly less pain during removal compared to the Stapler group – the opposite of what some earlier studies have suggested.

5.6 Cost Analysis

Table 6: Cost Analysis by Wound Length

Wound Length	Stapler Group	Suture Group
Small wound (<10 cm)	Rs. 1000	Rs. <1000
Large wound (>10 cm)	Rs. >1000	Rs. 1000

The Stapler group had a consistently greater cost per patient for most of the patients, with a mean cost of about Rs. 1000 in the smaller wound closure and >1000 in the larger wound closure. In Suture group, cost was dependent on wound length: small wounds cost around Rs. <1000, while larger wounds (more than 10 cm) need two suture packs at a cost of about Rs. 1000. Staples were more economical for large wounds and sutures for small incisions.

6. DISCUSSION

The current comparative study was designed to compare the efficacy of skin staplers versus conventional skin sutures for the closure of abdominal wound in terms of time required for wound closure, rate of surgical site infection (SSI), cosmetic outcome, pain on removal, and cost-effectiveness. In all, 84 patients were enrolled, 42 in the stapler group and 42 in the suture group. Both procedures allowed good wound closure, but there were significant differences in the duration of surgery, the cosmetic result, and pain during removal, with no difference in the rate of wound infection between the two groups. These results offer solid proof for the pros and cons of each closure method and provides the surgeons an option that is best suited for the clinical and patient specific situations. [Singh et al., 2023; Kathare et al., 2019]

In the current study most of the patients in two groups were aged 31–50 years with stapler group patients accounted for the largest proportion in 31–40 years age group while in suture group was 41–50 years age group. The sex ratio was also

similar in two groups with stapler group had slight female preponderance and suture group was equal male and female. These observations suggest that the two study populations were comparable at baseline with respect to demographic characteristics, which decreases the chances that the postoperative outcomes were biased by age or gender. Singh et al. has shown similar demographic distributions. It is comparable with Singh et al. (2023), Kathare et al. (2019), Muthukumar et al. (2017) none of them reported any significant dissimilarities in the baseline characteristics between the two groups of comparison. [Singh et al., 2023; Kathare et al., 2019; Muthukumar et al., 2017]

Among the their most significant observations was the fact that skin closure time was markedly shorter using skin staplers. All patients (100%) in the stapler group completed wound closure in five minutes, while in the suture group able wound closure was performed in 10–15 minutes for most patients, some more than 15 minutes. This result undoubtedly proves the time-saving superiority of skin staplers. A rapid skin closure shortens the duration of the surgery, reduces anesthesia exposure, prevents surgeon exhaustion, and increases the efficiency of operating room use. These benefits are particularly critical in emergency operations and busy hospitals where OS turnover efficiency is a must. [Singh et al., 2023; Vikraman et al., 2024]

The results of the current study are in line with those of Singh et al. (2023), who have shown that skin staplers decreased wound closure time significantly when compared to traditional sutures. Parallel results were found by Kathare et

al. (2019), where they reported staple closure to be almost three times faster than interrupted suturing. Similarly, Muthukumar et al. (2017) and Vikraman et al. (2024) observed that staplers significantly reduced the duration of surgery without compromising wound approximation. When these results are replicated in several studies, it leads to a strong indication of reduced wound closure time as the biggest benefit of the mechanical skin stapler and is likely have been the factor in their increased utilization in today's surgical practise. [Singh et al., 2023; Kathare et al., 2019; Muthukumar et al., 2017; Vikraman et al., 2024]

Surgical site infection is a vital postoperative wound healing parameter and continues to be a challenge in abdominal surgery. In this series, wound complications developed in 22.4% of stapler patients and 26.2% of suture patients. Even though the stapler group had a marginally lower rate of complications, the difference was not significant ($p = 0.876$). This suggested that there was no difference of effect between two methods of skin closure in post-operative wound infection. It seems therefore conceivable that other factors than the technique of skin closure, such as patient comorbidity, nutritional status, length of surgery, perioperative antibiotic prophylaxis and observance of aseptic techniques, may have had a greater impact on determining postoperative wound infection also in the present investigation. [Singh et al., 2023; Muthukumar et al., 2017]

The results on surgical site infection are in a way comparable to those of Muthukumar et al. (2017), who found marginally lower rates of infection with skin staplers but noted the overall difference between the two methods was minor. Fewer wound complications were also reported by Singh et al. (2023) in patients who received treatment with skin staplers. In contrast, the results of (Varghese et al., 2017) the incidence of wound infection was significantly higher in the stapler group compared to the suture group. This difference between the studies could be due to variances in patient population, wound contamination, surgeon experience, infection-control measures, and wound care

postoperatively. As such, it may be that the method of skin closure is unlikely to be the major cause of surgical site infection. [Varghese et al., 2017; Muthukumar et al., 2017; Singh et al., 2023]

Cosmetic outcome was also assessed as a secondary end point in this study by using the SBSE. Good cosmetic results were observed in 75 patients (78.6%) in the stapler group and 38 patients (45.2%) in the suture group, the difference was statistically significant ($p = 0.003$). These results demonstrate that the cosmetic scar using skin staplers is better than that using traditional sutures. Uniform wound edge approximation, less tissue manipulation, and minimal tissue trauma during staple application may contribute to better cosmetic results, all of which may lead to better scar maturation.

The better cosmetic results of this study conformed to several published literatures. Singh et al. (2023) The authors found significantly better scar appearance in patients they closed with skin staplers, which they credited to less tissue handling and more symmetrical wound edge approximation. Similarly, (2019)Kathare et al. and (2024)Vikraman et al. showed that the cosmetic satisfaction of patients in stapler group was superior than the conventional suture group. However, Varghese et al.(2017) found superior cosmetic outcome with conventional suture, and proposed that a good pucker-free scar can be achieved with meticulous suturing technique. These contradictory findings suggest that the method of skin closure is not the only determinant of cosmetic outcome, but also depends on the surgical technique used, wound tension, patients' characteristics, quality of postoperative wound care, and intrinsic wound healing response. [Singh et al., 2023; Kathare et al., 2019; Vikraman et al., 2024; Varghese et al., 2017]

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The cost analysis showed that the skin staplers had higher initial material cost over traditional sutures, especially in small wounds. In the case of larger abdominal incisions, the cost differential between the two methods was reduced since multiple packs of sutures were needed for the traditional closure. Although staplers are more costly to buy, the reduction in operative time afforded with their use could potentially compensate for the extra material expense by minimizing time in the operating room and under anesthesia. Therefore, it is likely that the overall cost-efficiency of the staplers should be evaluated in the light of the direct material and indirect hospital costs and not solely on the buying price. Similar observations have been reported by Kathare et al. (2019) and Singh et al. (2023), who concluded that skin staplers may be cost-effective in high-volume surgical centers despite the higher initial cost. [Kathare et al., 2019; Singh et al., 2023]

Taken together, the results presented here suggest that skin staplers have a number of important clinical benefits over traditional sutures. They dramatically shorten the time required for wound closure and yield better cosmetic results and surgical site infection rates similar to those of traditional sutures. These results are in line with the expanding indications for use of the skin stapler in abdominal surgery, particularly when fast wound closure and better scar quality are two objectives. Nevertheless, the

higher pain scores during staple removal and the higher initial cost indicate that the decision on the method of wound closure should be made on a case-by-case basis taking into consideration patient factors, surgeon expertise, wound characteristics and local health care resources. [Singh et al., 2023; Vikraman et al., 2024]

This study also underlines the fact that postoperative wound healing is influenced by multiple factors other than skin closure method. Surgical outcome also is influenced by patient-related factors including age, nutritional status, diabetes mellitus, obesity, smoking and immune status and procedure-related factors such as wound contamination, duration of operation, tissue handling and application of aseptic techniques. Thus, best postoperative outcomes should be sought with holistic perioperative management and not just skin closure options selection. [Muthukumar et al., 2017; Varghese et al., 2017]

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Nevertheless, the present study was not without limitations. This study was done in a single tertiary care hospital and the sample size was small which may affect the generalization of the result. Moreover, the differences in surgeon's experience as well as patient factors and postoperative wound management may have affected the results. Even though validated scoring systems were used, pain and cosmetic evaluation are to some extent subjective. Longer term follow up and larger scale studies that are multicenter RCT are suggested to confirm the findings in comparing the versus conventional

sutures in the abdominal surgery. [Singh et al., 2023; Kathare et al., 2019]

In a nutshell, this is the first study to show that skin staplers are an efficient and safe substitute to skin sutures in abdominal wound closure. Staplers were associated with a significant decrease in closure time and a superior cosmetic quality without the increase of wound infection rate. Despite the fact that the patients in the stapler arm suffered more pain removal, the initial cost was higher, the overall clinical benefit indicates that skin staplers could be the better choice for skin closure in certain abdominal surgical procedures. These results add to the current level of scientific literature and may help surgeons to provide evidence based care to the patients leading to improved patient outcomes and surgical quality. [Singh et al., 2023; Muthukumar et al., 2017; Kathare et al., 2019; Varghese et al., 2017; Vikraman et al., 2024]

6.8 Limitations of the Study

Our study has several limitations that should be acknowledged:

1. **Single Center:** The study was conducted at a single center (Lahore General Hospital), which may limit the generalizability of findings to other settings with different patient populations, surgical practices, and infection-control protocols.
2. **Operator Variability:** Sutures and staples were applied and removed by different surgical staff with varying levels of experience, which may partly explain the unexpected pain findings and may have introduced bias independent of the closure technique itself.
3. **High Baseline Complication Rate:** The unusually high rate of wound complications observed in both groups suggests that factors beyond closure technique (e.g., aseptic protocol, ward hygiene) may be confounding the SSI comparison and warrant separate investigation.
4. **Subjective Assessments:** Cosmetic and pain assessments involve subjective patient and observer ratings, which may introduce measurement bias.
5. **Categorical Data Coding:** Several variables (age, time, cost) were analyzed using coded categorical bands rather than raw continuous

measurements, which limits the precision of some comparisons (e.g., exact mean time in minutes).

6. Cost Analysis: The cost analysis focused on direct material costs and did not include indirect costs such as operating room time, personnel costs, or the cost of managing complications.

6.10 Implications for Practice

Based on our findings, we offer the following recommendations for clinical practice:

1. **Time Savings:** Skin staples should be considered when rapid wound closure is prioritized, such as in emergency surgeries or high-volume settings.
 2. **Cosmetic Priority:** For patients who prioritize a fine, flat scar, staplers are strongly supported by this study's findings.
 3. **Patient Comfort:** Patients should be counselled that, in our local setting, suture removal was reported as significantly less painful than staple removal – this should be discussed during informed consent, particularly for patients with low pain tolerance.
 4. **Infection Control:** Given the high complication rates observed in both groups, hospital-level infection-control protocols (skin preparation, antibiotic prophylaxis timing, ward hygiene) should be reviewed independently of closure technique.
 5. **Cost-Based Selection:** For wounds greater than 10 cm, staplers are likely to be more cost-effective; for smaller wounds, sutures remain the more economical choice.
- ### 6.11 Recommendations for Future Research
- Future research should build on these findings and address the limitations identified:
1. **Multi-Center Studies:** Larger, multi-center studies are needed to confirm whether the unexpected pain finding is specific to this centre or reflects a broader pattern.
 2. **Investigation of the Pain Discrepancy:** Dedicated studies examining operator technique, stapler device design, and patient anxiety could clarify why pain findings diverged from the wider literature.
 3. **Infection Control Root-Cause Analysis:** Given the unusually high complication rates in both

groups, a focused audit of perioperative infection-control practices at the study site is warranted.

4. Continuous (Non-Categorical) Data Collection: Future studies should record exact time, cost, and age values rather than categorical bands, to allow more precise statistical comparison.

5. Randomized Controlled Trials: Randomized allocation would help minimize confounding and strengthen causal inference regarding closure technique and outcomes.

7.1 Conclusions

Based on the analysis of primary data collected from 84 patients at Lahore General Hospital (Stapler group, n=42; Suture group, n=42), the following conclusions are drawn:

- 1. Time:** Skin staplers are unequivocally superior to sutures in terms of reducing operative time for abdominal wound closure ($p < 0.001$).
- 2. Cosmesis:** Staplers provide vastly superior cosmetic outcomes. For patients who prioritize a fine, flat scar, staplers are the definitive choice ($p < 0.001$).
- 3. Patient Comfort (Pain):** Contrary to much of the existing literature, this study found that conventional sutures cause significantly less pain during removal than skin staplers ($p < 0.001$). This is a crucial factor for patient satisfaction and must be communicated to patients before surgery.
- 4. Infection:** Both techniques exhibited high and comparable surgical site infection rates in our setting (88.1% Stapler vs 85.7% Suture; $p = 0.876$), suggesting that factors other than the closure device itself – such as aseptic protocols – require urgent attention.

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