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Comparison of Skin Stapling Devices and Conventional Skin Closure Following General Surgical Procedures

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ABSTRACT

Introduction: Wound closure is a critical aspect of surgical procedures, impacting healing, infection rates, and patient recovery. Skin stapling and conventional suturing are commonly used techniques, each with distinct advantages and limitations. This study aims to compare these methods in terms of closure time, postoperative pain, and surgical site infection rates to provide evidence-based guidance for optimal wound closure practices. **Methodology:** The study, conducted at Mayo Hospital, Lahore, from July 3, 2024, to January 2, 2025, included 120 patients undergoing general surgical procedures. Patients were randomized into two groups: Group A (stapling, n=60) and Group B (sutures, n=60). Standardized preoperative and intraoperative protocols were followed, and data on closure time, pain scores, and surgical site infections (SSI) were collected. Analysis was performed using SPSS version 24, with chi-square and t-tests to compare outcomes. Results were considered significant at $p \leq 0.05$. **Results:** The study demonstrated significant differences in outcomes between the two groups. Skin stapling (Group-A) resulted in a significantly shorter closure time (4.62 ± 1.10 minutes) compared to conventional suturing (Group-B) (11.57 ± 2.06 minutes, p=0.001), indicating greater efficiency with stapling. However, stapling was associated with a higher rate of surgical site infections (26.7% vs. 11.7%, p=0.037), suggesting an increased risk of complications. Additionally, patients in the stapling group reported lower pain scores (3.55 ± 0.80) compared to the suturing group (5.02 ± 0.58, p=0.001). **Conclusion:** Skin stapling provides faster closure and reduced pain but is associated with a higher risk of surgical site infections compared to conventional suturing. Careful consideration is required to balance efficiency and patient safety when choosing the closure method.

INTRODUCTION

The methodology of wound closure has progressed alongside human development from prehistoric times to the present. Achieving a closure that results in a cosmetically acceptable scar has consistently posed a significant challenge. The quintessential surgical wound should possess strength equivalent to that of normal tissue immediately upon closure. Research conducted by Douglas and Forester indicated that the maximum tensile strength restored to the tissue post-closure reaches only 80%, even after a follow-up period of one year. The techniques employed in wound closure have undergone considerable advancement over time. A variety of skin closure methods have emerged, replacing traditional sutures, including staples, adhesive tapes, and bonding agents.[1-2]

The ideal technique for skin closure must be characterized by simplicity, safety, speed, cost-effectiveness, lack of pain, bactericidal efficacy, and an aesthetically pleasing scar. While traditional suturing techniques have long been regarded as the gold standard for wound closure, the use of staples has gained traction in clinical settings more recently.[3]

Contemporary surgical staples can be either disposable, composed of plastic, or reusable, made of stainless steel. The utilization of staples presents several advantages, including rapid closure, reduced risk of infection, enhanced wound eversion without tissue strangulation, minimal cross-hatch scarring, and diminished foreign body reaction. Furthermore, the use of staples mitigates the potential for needle stick injuries

stemming from patients with unknown medical histories in healthcare practices.[4-5]

The choice of wound closure technique remains a debated topic, with no universally accepted gold standard. Pinky et al. demonstrated that staplers are significantly faster, with closure times averaging 60±15.3 seconds compared to 219.3±47.72 seconds for sutures ($p<0.001$), and cause less pain (VAS: 1.44±0.58 vs. 4.58±0.88, $p<0.001$).[5] Varghese et al. also reported shorter closure times with staplers (4.55±1.016 minutes) versus sutures (11.22±2.108 minutes), lower pain scores in stapler group (6.5±1.61 vs. 7.49±0.45), but higher infection rates (30% vs. 11.7%, $p=0.013$).[6]

In contrast, Maurer et al. found comparable infection rates between stapler and suture groups (16.6% vs. 13.5%, $p=0.47$), and Abdus-Salam observed no significant difference in pain scores on day 3 (2.83±2.27 vs. 2.74±2.24, $p=0.85$).[7-8] Gupta et al., however, documented significantly less pain in the stapler group (6.67% vs. 21.21%, $p=0.02$).[9] Chavan et al. reported higher VAS scores at one month for the stapler group (7.1±0.55) compared to the suture group (6.4±0.61, $p<0.0001$).[10] To this controversial international literature and lack of local data, we planned to carry out this study comparing the skin closure with stapling devices versus conventional skin closure following elective general surgical procedures.

METHODOLOGY

The study was conducted at Department of General Surgery, Mayo Hospital, Lahore from July 3, 2024 to January 2, 2025. A total of 120 patients were included in this study, fulfilling the inclusion criteria after the approval of ethical committee of hospital. A written informed consent was taken. Sample size of 120 (60 in each group) was calculated by using online sample size calculator (select-statistical services UK) with 5% level of significance, 80% power of study and taking the expected percentage of Surgical site infections being 30% with stapler technique and 11.7% in conventional suture technique.[5]

The study included patients aged 18 to 60 years undergoing general surgical procedures, such as ventral hernia repairs, open cholecystectomies, and thyroidectomies, who were ASA grades 1 and 2. Exclusion criteria included a history of skin allergies, keloid formation, hypertrophic scars, psychiatric conditions impairing communication, and hemoglobin levels below 10 g/dL.

Clinical data and demographic profiles were collected from patients undergoing elective surgical procedures, who were randomly assigned to two groups. Group A (n=60) had stapled skin closure, while Group B (n=60) had conventional closure. All patients followed hospital cleansing protocols, received prophylactic antibiotics, and had their skin prepped with povidone-iodine solution before surgery. Surgeries were conducted under general or spinal anesthesia, and hemostasis was ensured prior to wound closure.

In the staple closure technique, skin edges were everted and approximated using two Adson forceps, with staples placed 1 cm apart along the incision line using the B/Braun Manipler AZ-35W device. For conventional suture closure in thyroid surgeries, subcuticular sutures with vertical mattress stitches were spaced 1 cm apart using non-absorbable polypropylene. Skin closure time was noted for each patient, followed by dressing changes starting at 48 hours post-op until stitch or staple removal on the 8th day. Post-op pain was assessed on the 2nd, 7th, and 15th days, with surgical site infections (SSI) evaluated according to defined criteria. All data were documented on a dedicated form, and surgeries were carried out by the same team to minimize bias.

Data in SPSS v24 analyzed; quantitative variables (age, BMI, pain scores, time for closure) presented as means and standard deviations; qualitative variables (gender, SSI) as frequencies and percentages. Comparisons done using chi-square test for SSI and t-tests for pain scores and closure time. Confounders and effect modifiers (gender, age, BMI, diabetes mellitus) controlled through stratification, with post-stratification analyses using chi-square and t-tests. Statistical significance set at $p \leq 0.05$.

RESULTS

Gender distribution was similar, with males comprising 53.3% in Group-A and 55.0% in Group-B. Age groups were also comparable, with most patients aged 31-50 years (48.3% in Group-A, 43.3% in Group-B) and mean ages of 37.42 ± 12.37 years and 38.68 ± 12.58 years, respectively. BMI categories showed a slight difference, with more obese patients in Group-B (31.7%) compared to Group-A (25.0%), and a higher mean BMI in Group-B (27.59 ± 4.89 vs. 26.44 ± 5.00). Diabetes prevalence was slightly higher in Group-A (40.0%) compared to Group-B (35.0%) **(Table-1)**.

The mean time for closure was significantly shorter in Group-A (Skin stapling) at 4.62 ± 1.10 minutes compared to 11.57 ± 2.06 minutes in Group-B (Skin sutures), with a p-value of 0.001 indicating statistical significance. Similarly, the mean pain score (VAS) was lower in Group-A (3.55 ± 0.80) than in Group-B (5.02 ± 0.58), with a p-value of 0.001 **(Table-2)**. The rate of surgical site infections (SSI) was significantly higher in Group-A (Skin stapling) with 16 patients (26.7%) compared to 7 patients (11.7%) in Group-B (Skin sutures), yielding a p-value of 0.037 **(Table-3)**. Stratification of outcome variables between groups with respect to different variables was done and shown in tables (Table-4 and 5).

Table 1
Comparison of distribution of different variables between groups

Variables		Groups	
		Group-A (Skin stapling)	Group-B (Skin sutures)
Gender	Male	32(53.3%)	33(55.0%)
	Female	28(46.7%)	27(45.0%)
Age groups	18-30 years	19(31.7%)	18(30.0%)
	31-50 years	29(48.3%)	26(43.3%)
	51-60 years	12(20.0%)	16(26.7%)
	Mean±S.D	37.42±12.37	38.68±12.58
BMI	Normal	25(41.7%)	22(36.6%)
	Overweight	20(33.3%)	19(31.7%)
	Obese	15(25.0%)	19(31.7%)
	Mean±S.D	26.44±5.00	27.59±4.89
Diabetes mellitus	Yes	24(40.0%)	21(35.0%)
	No	36(60.0%)	39(65.0%)

Table 2
Comparison of time for closure and pain score between groups

Outcome variables	Groups		p-value
	Group-A (Skin stapling)	Group-B (Skin sutures)	
Time for closure (minutes)	4.62±1.10	11.57±2.06	0.001
Pain score (VAS)	3.55±0.80	5.02±0.58	0.001

Table 3
Comparison of SSI between groups

Surgical site infection (SSI)	Groups		p-value
	Group-A (Skin stapling)	Group-B (Skin sutures)	
Yes	16(26.7%)	7(11.7%)	0.037
No	44(73.3%)	53(88.3%)	
Total	60(100.0%)	60(100.0%)	

Table 4
Stratification of time for closure and pain score between groups with respect to different variables

Variables	Outcome variables	Group-A (Skin stapling)	Group-B (Skin sutures)	p-value
Gender				
Male	Time for closure	4.76±1.12	11.49±2.16	0.001
	Pain score	3.47±0.84	4.98±0.55	0.001
Female	Time for closure	4.46±1.08	11.67±1.98	0.001
	Pain score	3.66±0.76	5.08±0.62	0.001
Age groups				
18-30 years	Time for closure	4.22±1.29	11.99±1.92	0.001
	Pain score	3.28±0.76	4.83±0.70	0.001
31-50 years	Time for closure	4.94±1.00	11.49±2.14	0.001
	Pain score	3.74±0.83	5.26±0.50	0.001
51-60 years	Time for closure	4.45±0.85	11.23±2.14	0.001
	Pain score	3.55±0.71	4.85±0.43	0.001
Body Mass Index				
Normal	Time for closure	4.81±1.12	11.52±2.28	0.001
	Pain score	3.51±0.81	5.20±0.65	0.001
Overweight	Time for closure	4.22±0.94	11.32±1.67	0.001
	Pain score	3.67±0.85	5.05±0.57	0.001
Obese	Time for closure	4.83±1.21	11.88±2.22	0.001
	Pain score	3.48±0.76	4.79±0.43	0.001
Diabetes MELLITUS				
Yes	Time for closure	4.71±1.12	12.33±1.98	0.001
	Pain score	3.60±0.82	5.03±0.642	0.001
No	Time for closure	4.56±1.11	11.16±2.01	0.001
	Pain score	3.52±0.80	5.02±0.55	0.001

Table 5
Stratification of SSI between groups with respect to different variables

Variables	SSI	Group-A (Skin stapling)	Group-B (Skin sutures)	p-value
Gender				
Male	Yes	8(25.0%)	1(3.0%)	0.010
	No	24(75.0%)	32(97.0%)	
Female	Yes	8(28.6%)	6(22.2%)	0.589
	No	20(71.4%)	21(77.8%)	
Age groups				
18-30 years	Yes	8(42.1%)	1(5.6%)	0.010
	No	11(57.9%)	17(94.4%)	
31-50 years	Yes	5(17.2%)	5(19.2%)	0.849
	No	24(82.8%)	21(80.8%)	
51-60 years	Yes	3(25.0%)	1(6.3%)	0.161
	No	9(75.0%)	15(93.7%)	
Body Mass Index				
Normal	Yes	8(32.0%)	2(9.1%)	0.056
	No	17(68.0%)	20(90.9%)	
Overweight	Yes	4(20.0%)	4(21.1%)	0.935
	No	16(80.0%)	15(78.9%)	
Obese	Yes	4(26.7%)	1(5.3%)	0.080
	No	11(73.3%)	18(94.7%)	
Diabetes Mellitus				
Yes	Yes	9(37.5%)	4(19.0%)	0.173
	No	15(62.5%)	17(81.0%)	
No	Yes	7(19.4%)	3(7.7%)	0.135
	No	29(80.6%)	36(92.3%)	

DISCUSSION

This study compared the effectiveness of skin stapling and conventional suturing for wound closure in patients undergoing general surgical procedures. The results demonstrated significant differences between the two techniques in terms of closure time, pain scores, and surgical site infections (SSI), providing valuable insights into their respective advantages and limitations.

In this study, skin stapling (Group-A) resulted in a significantly shorter closure time (4.62 ± 1.10 minutes) compared to conventional suturing (Group-B) (11.57 ± 2.06 minutes, p=0.001), indicating greater efficiency with stapling. However, stapling was associated with a higher rate of surgical site infections (26.7% vs. 11.7%, p=0.037), suggesting an increased risk of complications. Additionally, patients in the stapling group reported lower pain scores (3.55 ± 0.80) compared to the suturing group (5.02 ± 0.58, p=0.001).

Pinky et al, explained the mean duration of time taken for stapler closure was 60±15.3 seconds whereas with the application of suture was 219.3±47.72 seconds. The time taken was four times more than that of stapler closure (p<0.001), while with stapler, the mean pain score in VAS was 1.44±0.58 whereas with suture, the mean pain score in VAS was found to be 4.58±0.88, which was found to be statistically significant (p<0.001).[5]

Varghese et al, showed a significant wound infection rate in stapler group (30%) as compared to conventional suture group (11.7%) with p-value 0.013. Mean time for closure was significantly shorter in stapler group (4.55±1.016) minutes, when compared to conventional suture group (11.22±2.108) minutes. The mean pain score in staples group was (6.5±1.61) and in sutures group is (7.49±0.45).[6]

On the contrary, Maurer et al., showed comparable wound infection rates (16.6% in staple group vs. 13.5% in conventional suture group with p-value 0.47).[7] Abdus-Salam showed no statistically significant difference for mean pain score 2.83±2.27 for staple group vs. 2.74±2.24 for suture group with p-value 0.85 on day 3.[8] Gupta et al., 2015 documented significantly less pain in staple group (6.67% patients experienced pain) as compared to staple group (21.21% patients experienced pain) with a p-value of 0.02 on day 3.[9]

In Chavan et al study, the average VAS score of patients in staple group at the end of one month was 7.1±0.55; while the average for suture group was 6.4±0.61 and p-value was <0.0001 which was highly significant.[10] A study conducted by Tuuli MG et al, showed that Staple closure was associated with a twofold higher risk of wound infection or separation compared with subcuticular suture closure.[11] A multicentric study among 1080 patients conducted by Tsujinaka T et al, showed no significant difference in wound infection between the two groups.[12]

A major strength of our study was the random allocation of patients into groups, which helped reduce selection bias. Additionally, standardizing surgical protocols, such as antibiotic prophylaxis and wound care, ensured uniformity across both groups. However, our study was limited by its sample size, which, although sufficient for detecting differences in primary outcomes, may not capture less common complications or long-term outcomes. Further large-scale studies are recommended to validate these findings and explore the cost-effectiveness of stapling versus suturing in diverse surgical settings.

The findings from this study provide important clinical insights. While stapling offers the advantages of reduced closure time and lower postoperative pain, the associated higher risk of SSI warrants careful consideration. Surgeons must weigh the benefits of efficiency against the potential for complications, particularly in patients at higher risk for infections, such as those with diabetes or compromised immune systems. Adopting strategies to improve stapling techniques and ensuring rigorous postoperative monitoring can help optimize outcomes.

CONCLUSION

Skin stapling provides faster closure and reduced pain but is associated with a higher risk of surgical site infections compared to conventional suturing. Careful consideration is required to balance efficiency and patient safety when choosing the closure method.

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