



Different Techniques used for Stump Closure in Laparoscopic Appendectomy

**Shafaqat ^{a≡}, Syed Ashraf Hassan ^{a°}, Haris Rashid ^{a#}, Mir Arsalan Ali ^{a†},
Fatima Zehra Khan ^{a‡} and Santosh Kumar Sidhwani ^{b†}**

^a Department of Surgery, Ziauddin University and Hospital, Pakistan.

^b Department of Pathology, Ziauddin University, Pakistan.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2022/v34i33B36134

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/85335>

Original Research Article

Received 22 January 2022

Accepted 29 March 2022

Published 22 April 2022

ABSTRACT

Background: The most prevalent surgical emergency for which patients present to the emergency room is acute appendicitis. Appendectomy is the surgical therapy for the problem, and it is one of the most common surgeries performed worldwide, with almost a quarter of all people (equally males and females) requiring one at some point in their lives. Methods that are used to close the stump in laparoscopic appendectomy include staplers, endo-loop, titanium clips, non-absorbable polymer clips (Hem-o-lock clips), hand-made loops, extracorporeal sliding knot, intra-corporeal ligation, ligature use or division with bipolar cautery.

Objective: To compare various methods of stumps closure in laparoscopic appendectomy.

Methods: This Double Blind – Randomized Quasi Experimental Trial was conducted upon a sample of 80 patients (selected using non-probability, consecutive sampling) in four groups (G1: Endoloop, G2: Intracorporeal Knotting with Vicryl Size 2/0, G3: Extracorporeal Knotting with Chromic Catalent no Zero, G4: Vicryl Intracorporeal Trans fixation of Stump with 2/0 vicryl) of 20 each. Data was recorded onto a structured questionnaire containing inquiries pertaining to basic biodata, sociodemographic details, disease history, operative notes and post-operative follow-up.

[≡] PG (MS);

[°] Professor;

[#] Chairman & Professor;

[†] Assistant Professor;

[‡] Senior Registrar;

*Corresponding author: E-mail: santosh.kumar@zu.edu.pk;

The data obtained was analyzed using SPSS 21.0 and MS. Excel.

Results: The mean age of the sample stood at 43.96 (SD \pm 16.9) years, with the age ranging from 17 to 80 years. Study more females were presented in all four groups. They have shown insignificant statistical association with p-value of 0.983. Post-operative complication in every group was recorded as post-operative hemorrhage, knot slippage, abscess and surgical site infection. Overall in 9 (11.3%) of patients experienced different post-operative complications showed insignificant statistical association with the p-value of 0.945.

Conclusion: In current study we concluded that endoloop is the most efficient and less time consuming procedure used for the stump closure in the patient undergo laparoscopic appendectomy. Intra operative time taken is also less compared to other groups. Less number of intra-operative and post-operative complication were noted in the endoloop group. Hospital stay is also observed to be less in the endoloop group.

Keywords: Surgical emergency; endoloop group; laparoscopic appendectomy; titanium clips.

1. INTRODUCTION

One of the most common surgical emergencies requiring immediate admission to the hospital is acute appendicitis. Acute appendicitis is the most common presentation of the acute abdomen in the world, with a 52 per 100,000 incidence [1]. It accounts for over 25% of surgical ward admissions, and approximately 40% of procedures are performed in emergency rooms. Initial treatment comprises of a nil-per-oral regimen, antibiotics, and pain relievers with intravenous fluids, although surgery is almost always required for acute appendicitis. This can be accomplished by an open or laparoscopic procedure [2, 3].

When opposed to the open operation, the majority of appendectomies are performed laparoscopically, which has been shown to result in less post-operative pain, a lower rate of wound infection, faster recovery, and a shorter hospital stay [4]. However, the laparoscopic technique is linked to longer process durations, greater costs, and a higher risk of intra-abdominal abscess formation after surgery [5]. Additionally, appendiceal stump leakage due to insufficient stump closure is a well-known consequence of laparoscopic appendectomy [6]. Closure of the appendicular stump during laparoscopic appendectomy is a point of contention and continuing research [7].

In laparoscopic appendectomy, various stump closure techniques have been described, including intra- and extracorporeal knots, staplers, polymeric endoclips, and endoloops [8]. However, there is no agreement on the best way to close an appendiceal stump. The current literature reveals the relative benefits and drawbacks of such procedures for securing the

appendiceal stump, but no thorough assessment of the current evidence has been undertaken to our knowledge [9]. The ease of application and degree of stump inflammation were the most critical criteria in determining the method of choice for securing the stump. Cost was a big factor on technique of choosing for 34.2 percent of respondents [10,11]. The objective of current study was to compare the efficacy of various methods of stumps closure in laparoscopic appendectomy.

2. METHODS

This was a Double Blind – Randomized Quasi Experimental Trial conducted at Department of Surgery, Ziauddin University Hospital. Total 80 consenting patients (both genders) aged 18 to 70 years who arrive with acute appendicitis to the study setting were recruited meeting the inclusion criteria by the Non-Probability – Consecutive Sampling. Non-consenting patients, as well as patients with a history of abdominal or pelvic tuberculosis, puerperal sepsis, diabetes, cases of pneumoperitoneum establishment machinery failure, and patients who were unfit for surgery due to poor cardiac or aesthetic fitness, were excluded from the study.

2.1 Data Collection and Patient Characterization

All patients admitted to the study setting for a laparoscopic appendectomy and meeting the eligibility requirements were randomly assigned to one of the groups named G1: Endoloop, G2: Intracorporeal Knotting with Vicryl Size 2/0., G3: Extracorporeal Knotting with Chromic Catalent no Zero, G4: Vicryl Intracorporeal Trans fixation

of Stump with 2/0 vicryl. Data was obtained using a pre-structured questionnaire that included questions regarding basic biodata, sociodemographic information, the presenting complaint, clinical presentation, stump closure type, surgery specifics, and procedure outcome after gaining written informed consent. Prior to surgery, all patients had blood tests and an abdominal ultrasound. A consultant general surgeon with at than five years of post-fellowship experience performed all of the surgeries (following all established institutional protocols). The surgeries were all performed under general anesthesia utilizing disposable equipment and a three-trocars technique. After surgery, the appendiceal stump was cleansed with polyvidone-iodine before any of the closure techniques could be performed. The patients were given an intravenous antibiotic prophylaxis one hour prior to the procedure, followed by a therapeutic dose given during their stay in the hospital. During the surgery, patients were monitored for the type of closure technique used, operating duration, knot tying issues, and intra-operative bleeding. The full cost of your hospital stay will be paid as well. A one-week, two-week, and four-week follow-up was performed. Patients were checked for signs of hematoma or seroma formation, knot slippage leading to bowel content leakage and peritonitis, abscess or surgical site infection, or post-operative pain during their follow-up appointments.

2.2 Randomization of Samples

The randomization process was performed using a web based free software available at <http://www.randomizer.org>. Researcher who was uninvolved in any of the experimental phases, performed this procedure. The randomization list was numbered consecutively and individually placed in sealed envelopes. These envelopes were opened on the day of surgical treatment to prevent any bias. All participants, operator and evaluators were blinded to the group allocation during examinations.

2.3 Data Analysis Procedure

Data was analyzed using Microsoft Excel 2016 and SPSS v. 21.0. Qualitative (gender, residential/socio-economic status, type of stump closure technique adopted, type of outcome/complication encountered) data was expressed as number and percentage (No & %). Quantitative (age, number of complications encountered, operative time, self-rated difficulty

level by surgeon, hospital stay and total cost) data was expressed as mean & standard deviation ($X \pm SD$). Pearson's coefficient was used to assess presence of association between type of approach for stump closure and surgical outcomes. Chi square test, one way ANOVA was applied to assess strength of association. A P value of less than or equal to 0.05 was taken as significant.

3. RESULTS

The sample's mean age was 43.96 (SD 16.9) years, with ages ranging from 17 to 80. All patients are grouped into three age groups for statistical purposes: 17 to 38 years old, 39 to 58 years old, and 59 to 80 years old. 34 (42.5%) of the patients in this study were between the ages of 17 and 38, with the remaining 29 (36.3%) being between the ages of 39 and 58, and 17 (21.2%) being between the ages of 59 and 80. Females made up 49 (61.2%) of the hospitalized patients, while males made up 31 (38.8%). The majority of the study participants (63, or 78.8%) had no prior abdominal surgery history, but a few had a C-section (7, or 8.8%), laparoscopic cholecystectomy (6, or 7.5%), open cholecystectomy (1, or 1.3%), left inguinal hernia repair (1, or 1.3%), or TAH+BSO (1, or 1.3%). (2: 2.3%). The average operative time was 64.4 minutes (SD 22.4 minutes). There was no intraoperative hemorrhage in 49 (61.2%) of the patients, while 31 (38.8%) of the patients had intraoperative hemorrhage. Only 9 (11.3%) of patients had post-operative hemorrhage, whereas 71 (88.7%) had no post-operative problems. As demonstrated in Table 1.

Furthermore on comparative statistical analysis of the all four groups with different parameters we found that age has no any significant statistical association with the techniques of stump closure having the p-value of 0.980 and so do gender, p-value of 0.983. We also wanted to see if previous abdominal surgery had anything to do with the present surgical operation in this study. We found no evidence of a link between the existing approach and the outcome, p value 0.844.

Furthermore, in this study, we attempted to establish a statistical link between the surgeon's ease of operation during stump closures in laparoscopic appendectomy in all groups. On a scale of one to five, we rated the difficulty index as follows. 1=very simple, 2=simple, 3=tough, 4=hard, and 5=extremely difficult. In the current

trial, we discovered a highly significant relationship with a p-value of 0.001, indicating that endoloop is highly recommended for stump closure. A large number of patients in Group2: Intracorporeal Knotting with Vicryl Size 2/0 (11: 13.8%), and Group3: Extracorporeal Knotting with Chromic Catalent no Zero (13: 15%), had

the intra operative hemorrhage during the procedure and least number is seen in Group1: Endoloop (3: 3.8%) as shown in the table 2 and 3. they have significant statistical link between the groups and the intra operative hemorrhage with the p-value of 0.006.

Table 1. Descriptive Statistics Summary of study subjects

Variable		Statistic – n (%)
Age groups (Years)	17 to 38 Years	34 (42.5%)
	39 to 58 Years	29 (36.3%)
	59 to 80 Years	17 (21.3%)
Gender	Male	31 (38.8%)
	Female	49 (61.2%)
Past abdominal surgery	Yes	17 (21.2%)
	No	63 (78.8%)
Difficulty index	Very easy	29 (36.2%)
	Easy	27 (33.8%)
	Difficult	17 (21.2%)
	Hard	7 (8.8%)
Intra operative hemorrhage	Very Difficult	0 (0%)
	Yes	31 (38.8%)
	No	49 (61.2%)
	Two days	55 (68.7%)
Hospital stay in Days	Three days	23 (28.7%)
	Four days	1 (1.3%)
	Seven days	1 (1.3%)
Post-operative complications	Yes	9 (11.2%)
	No	71 (88.8%)
VAS pain score	0-2 (No pain)	1 (1.3%)
	3-4 (Mild pain)	63 (78.7%)
	5-6 (Moderate pain)	12 (15%)
	>6 Severe Pain	4 (5%)

Table 2. Statistical comparison between Groups with respect to the different study variables

Variable		Group 1	Group 2	Group 3	Group 4	P Value
Age groups (Years)	17 to 38 Years	8 (10%)	10 (12.5%)	7(8.8%)	9 (11.2%)	0.980 ^a
	39 to 58 Years	8 (10%)	6 (7.5%)	8 (10%)	7 (8.8%)	
	59 to 80 Years	4 (5%)	4 (5%)	5 (6.2%)	4 (5%)	
Gender	Male	8 (10%)	8 (10%)	7(8.8%)	8 (10%)	0.983 ^a
	Female	12 (15%)	12 (15%)	13 (16.2%)	12 (15%)	
Previous abdominal surgery		3(3.8%)	5 (6.2%)	4(5%)	5 (6.2%)	0.844 ^a
	Yes	1 (TAH+BSO)	2 (C-Section)	1 (TAH+BSO)	1 (Open Chole)	
		1 (Left inguinal hernia repair)	3 (Lap Chole)	2 (Lap Chole)	1 (Lap Chole)	
	No	17 (21.2%)	15 (18.8%)	16 (20%)	15 (18.8%)	

Variable		Group 1	Group 2	Group 3	Group 4	P Value
Difficulty index	Very Easy	17 (21.2%)	0 (0%)	12(15%)	0 (0%)	0.001 ^a
	Easy	3 (3.8%)	9 (11.3%)	8 (10%)	7 (8.8%)	
	Difficult	0 (0%)	9 (11.3%)	0 (0%)	8 (10%)	
	Hard	0 (0%)	2 (2.4%)	0 (0%)	5 (6.2%)	
	Very difficult	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Intra operative hemorrhage	No	17 (21.2%)	9 (11.3%)	15 (18.8%)	8 (10%)	0.006 ^a
	Yes	3 (3.8%)	11 (13.7%)	5 (6.2%)	12 (15%)	
Operative time taken by surgeon (Minutes)	Mean	40 (SD ± 3.4)	64.4 (SD ± 22.7)	59.6 (SD ± 19.4)	61.7 (SD ± 18.1)	0.001 ^{b*}
	Range	36 to 40	49 to 80	51 to 60	38 to 120	
Hospital stay (Days)	Mean	2 (SD ± 0.11)	4 (SD ± 0.41)	3.5 (SD ± 0.31)	3.5 (SD ± 0.23)	0.006 [*]
	Range	2 to 7	2 to 7	2 to 7	2 to 7	
VAS pain score index	Mild pain (3-4)	19 (23.7%)	13 (16.2%)	16 (20.0%)	15 (18.8%)	0.035 ^a
	Moderate pain (5-6)	1 (1.3%)	6 (7.5%)	3 (3.7%)	2 (2.5%)	
	Severe pain (>6)	0 (0%)	1 (1.3%)	1 (1.3)	3 (3.7%)	

^aPearson Chi-square test, ^{*}One way ANOVA, Group1: Endoloop, Group2: Intracorporeal Knotting with Vicryl Size 2/0, Group3: Extracorporeal Knotting with Chromic Catalent no Zero, Group4: Vicryl Intracorporeal Transfixation of Stump with 2/0 vicryl

Table 3. Association of the Study groups with the post-operative complications

Variable		Group 1	Group 2	Group 3	Group 4	P Value
Post-operative complications	No	18 (22.5%)	17 (21.3%)	18 (22.5%)	18 (22.5%)	0.945 ^a
	Yes	2 (2.5%)	3 (3.8%)	2 (2.5%)	2 (2.5%)	

^aPearson Chi-square test

Group1: Endoloop, Group2: Intracorporeal Knotting with Vicryl Size 2/0., Group3: Extracorporeal Knotting with Chromic Catalent no Zero, Group4: Vicryl Intracorporeal Transfixation of Stump with 2/0 vicryl

Table 4. Association of the Study groups with the different complications

Variable		Group 1	Group 2	Group 3	Group 4	P Value
Post-operative complications	Post-operative hemorrhage	0	0	0	0	0.945 ^a
	Knot slippage	0	0	0	0	
	Abscess	0	1	0	1	
	Surgical site infection	2	2	2	1	

^aPearson Chi-square test

Group1: Endoloop, Group2: Intracorporeal Knotting with Vicryl Size 2/0., Group3: Extracorporeal Knotting with Chromic Catalent no Zero, Group4: Vicryl Intracorporeal Transfixation of Stump with 2/0 vicryl

We also described the hospital stay in days and the surgeon's operative time in minutes while conducting the procedure in the current study. We discovered that group 1 has a substantially lower mean hospital stay and surgical time than

the other groups, as shown in the table: 4. Both had a statistically significant association with the groups, with p-values of 0.006 and 0.00, respectively. On comparison of post-operative VAS pain score index with the all group we found

that 19 (23.7%) experienced mild pain in group 1 while in group 2, 13 (16.2%) , 16 (20%) in group 3 and 15 (18.8%) in group 4 had mild pain as shown in table 1. VAS-score has significant statistical association with the groups (p-value 0.035). Table 2.

Post-operative complication in every group was recorded as post-operative hemorrhage, knot slippage, abscess and surgical site infection. Overall in 9 (11.3%) of patients experienced different post-operative complications as shown in table 2. they showed insignificant statistical association with the p-value of 0.945. Table 3 and 4.

4. DISCUSSION

Various stump closure procedures, including as intra- and extracorporeal knots, staplers, polymeric endoclips, and endoloops, have been described in laparoscopic appendectomy. Several researches compared various strategies in order to find the best method. The sample's mean age was 43.96 (SD 16.9) years, with participants ranging in age from 17 to 80 years. Same findings were recorded (mean age 37.6 ± 8.5) by A. Talha et al, and his colleagues in their randomized clinical trial done in 2020 [12]. Another prospective randomized study conducted at the Department of Surgery, Holy Family Hospital, Rawalpindi, Pakistan, from January 2016 to January 2017 by Nazir A. et al, and his colleagues also concluded the mean age of 32 ± 7 years [13].

In current study majority of the patients admitted were females 49 (61.2%) and 31 (38.8%) were males. This is in line with earlier findings in France on appendicitis prevalence by gender (females 57.8 percent vs males 42.2 percent) [14]. Furthermore, the greater risk of males against females and age 50 versus age > is consistent with current research and supports our findings [15].

There were no intraoperative hemorrhages in many of the patients. Intraoperative hemorrhage occurred in 49 (61.2%) of the patients, while 31 (38.8%) experienced it. Only 9 (11.3%) of patients experienced post-operative hemorrhage, while 71 (88.7%) had no post-operative problems. Number of post-operative complications in much lesser in group in which endoloop was used for stump closure compared to the other groups where Intracorporeal Knotting with Vicryl Size 2/0, Extracorporeal Knotting with

Chromic Catalent no Zero and Vicryl Intracorporeal Trans fixation of Stump with 2/0 vicryl were used. Operative time is also less in endoloop 40 (SD ± 3.4) minutes compared to Intracorporeal Knotting with Vicryl Size 2/0, 64.4 minutes (SD ± 22.7), Extracorporeal Knotting with Chromic Catalent no Zero 59.6 minutes (SD ± 19.4) and Vicryl Intracorporeal Trans fixation of Stump with 2/0 vicryl 61.7 minutes (SD ± 18.1). Endoloop appears to be one of the most durable closure procedures, but it is also associated with a high risk of postoperative complications, and the related expenses limit its usage to only the most severe instances of appendicitis [16,17]. Intraoperative complications occurred at a low rate of 2.5%. According to the existing literature, Endoloop is an effective and simple to use closure technique with a low risk of intraoperative complications [18].

Beldi et al. [16] presented a large prospective series that supports the lower post-operative complication rate seen with Endoloop vs. staples, however the difference was not statistically significant. Swank et al. [19] on the other hand, found no significant difference in operative time or peri-operative problems when comparing endostapler with Endoloop. In a retrospective examination of 1790 patients, Sahm et al. [20] found a decreased incidence of intra-abdominal abscess with Endoloop compared to staples, as well as a 19-minute reduction in surgical time.

Our findings are in line with those of a recent Cochrane review, which looked at all published randomized controlled trials evaluating various procedures of appendiceal stump closure up until 2017 [21]. There was no significant difference in the rate of overall problems, intra- and post-operative complications, or overall hospital stay, according to the researchers. Furthermore, according to our data, there was a significant variation in operation duration. Yldz et al [22]. found that stump closure using a homemade endoloop was both cost-effective and safe in a trial of 98 patients.

In terms of wound infection, Antoniou et al. [23] found that suture stump closure was superior to alternative approaches. Two patients (2.5%) in the endoloop group and two patient (2.5%) in the Intracorporeal Knotting with Vicryl Size 2/0 group and Extracorporeal Knotting with Chromic Catalent no Zero acquired wound infection in our study. In terms of wound infection, we found no statistically significant differences between the two techniques.

Imşek et al. [24] examined a polymeric endoclip and an endoloop in stump closure during laparoscopic appendectomy and found that the polymeric endoclip facilitated the surgical approach and cut operation time in half. In another study done by Bali et al. [25] compared intracorporeal ligation to an endoloop and found that the endoloop saved operation time. Appendiceal stump closure using a Hem-o-lok clip and an endoloop were compared by Lucchi et al. [7]. The endoloop took 40.5 minutes and the Hem-o-lok clip took 36.4 minutes on average. The two groups had identical lengths of stay in the hospital, and there was no statistically significant difference in the number of problems.

5. CONCLUSION

In current study we concluded that endoloop is the most efficient and less time consuming procedure used for the stump closure in the patient undergo laparoscopic appendectomy. Intra operative time taken is also less compared to other groups. Less number of intra-operative and post-operative complication were noted in the endoloop group. Hospital stay is also observed to be less in the endoloop group.

6. LIMITATIONS

There are various limitations to our research. For starters, due to the sequential series of patients, the sample could be slightly skewed. Second, we lacked information on family history in our study participants. As a result, our findings were exclusively dependent on the patients' understanding of their family history reaction. Third, the male-to-female ratio was unbalanced. Finally, pathology results for some patients were unavailable.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

IRB: Approved by Ethical Review Committee, Ziauddin Medical University, Ref# 3090121SGS.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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 The peer review history for this paper can be accessed here:
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