ORIGINAL ARTICLE

Comparative study between Intracorporeal versus Extracorporeal knot tying in Laparoscopic Appendectomy

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Abstract

Background: ***Many people deal with the discomfort and difficulty of acute appendicitis. Surgery is the primary therapeutic option, while antibiotics can be used in rare instances.***

Aim: ***To compare extracorporeal and intracorporeal knot tying in laparoscopic appendectomy concerning efficiency and reliability.***

Subjects and methods: ***Forty patients undergoing surgery at Al-Azhar University Hospitals in Cairo, Egypt's General Surgery Department, between August 2024 and February 2025 were the subjects of this prospective randomized interventional trial.***

Results: ***One patient in group A and three patients in group B experienced superficial wound infections as postoperative complications; one patient in each group experienced delayed peristalsis; and one patient in group B had an intra-abdominal abscess. There was no occurrence of fecal fistula, hemorrhage, or port site hernia in either group of individuals that were investigated. On the subject of postoperative complications, there was no discernible difference between the two groups. Compared to group B, group A had a considerably lower operating time (47.35±10.97min vs. 62.55±11.23min, P<0.001). Concerning the installation of drains and intraoperative bleeding, there was no statistically significant difference between the two groups.***

Conclusion: ***Extracorporeal and intracorporeal knot-tying techniques in laparoscopic appendectomy are both safe and effective. However, extracorporeal knotting was associated with a significantly shorter operative time.***

Keywords: Laparoscopic appendectomy; ECK; ICK

1. Introduction

One simple and risk-free surgical procedure is the open appendectomy. Laparoscopic appendectomy is the alternative surgical procedure. Laparoscopic appendectomy is becoming increasingly popular due to its many benefits, including reduced postoperative discomfort, quicker recovery, shorter hospital stays, and improved visualization of the lower abdominal quadrants.[1]

The gold standard for treating acute appendicitis, according to recent guidelines, is laparoscopic appendectomy.[2]

Appendectomy knot tying is a crucial part of the procedure that, if done incorrectly, can cause major problems after the operation.[3]

Various techniques are available for appendix closure in laparoscopic surgery, including the use of an endo-stapler, an endo-loop, a metal clip, bi-polar endo-coagulation, Hem-o-lok clips, and both intra- and extracorporeal knotting.[4]

Every approach has its own set of pros and cons. When it comes to recovery time, postoperative pain scale, and cost, there are currently insufficient studies. Consequently, there is still no consensus on how to properly close the appendix stump after a laparoscopic appendectomy.[5]

Contrarily, another safe and economical closure procedure is intracorporeal knotting.[6]

In terms of efficiency and dependability, this study aimed to compare intracorporeal knot tying with extracorporeal knot tying during laparoscopic appendectomy.

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2. Patients and methods

Forty patients undergoing surgery at Al-Azhar University Hospitals in Cairo, Egypt's General Surgery Department, between August 2024 and February 2025, were the subjects of this prospective randomized interventional trial.

Inclusion criteria:

Age between 14-80 years, patients diagnosed with acute appendicitis, patients who are fit for anesthesia without complications (The American Society of Anesthesiologists class 1 or 2), and both sexes.

Exclusion criteria:

Patients with a complicated appendix, such as an appendicular mass or abscess, patients with any contraindications that restrict laparoscopic surgery, patients who are unable or unwilling to comply with postoperative follow-up requirements, patients who are unfit for anesthesia (ASA class>II), patients with coagulation disorders until corrected, and patient refusal.

Sample size calculation:

In a simultaneous fashion, forty patients were randomly assigned using computer-generated numbers, and each patient's code was kept in an opaque envelope: The appendiceal stump and mesoappendix in Group A (n=20) were bound using extracorporeal knotting with 2/0 Vicryl, but in Group B (n=20), the same knotting was applied intracorporeally.

A comprehensive history was taken from each patient, followed by a thorough physical examination, a systemic examination, an abdominal and pelvic ultrasound, regular laboratory investigations, an electrocardiogram (ECG), and, if necessary, a chest x-ray.

Methods:

Preoperative management:

All patients underwent a thorough preoperative assessment, including control of concomitant illnesses such as hypertension and diabetes. Diabetic patients had their blood glucose levels optimized before surgery. Antibiotic prophylaxis was administered to all patients using a broad-spectrum antibiotic, specifically a third-generation cephalosporin (cefotaxime). A dose of 1g of cefotaxime was given intravenously preoperatively, followed by a second dose two hours postoperatively. Further antibiotic administration was based on the patient's condition.

Procedure:

Under general anesthesia, all patients underwent laparoscopic appendectomy, with the procedure divided into two groups:

Extracorporeal Knotting (Group-A):

A 2/0 Vicryl suture was used in conjunction with Roeder's and Mishra's sliding knots. The appendix's base was fastened with three knots. In order to make the Roeder's knot, one hitch, three winds, and one locking hitch were produced outside of the belly cavity according to the (1:3:1) formula. Prior to inserting it into the abdominal cavity through the trocar, the knot's sliding ability was evaluated. After threading the appendix through the loop, a Maryland dissector was used to tighten the knot. The suture's tip was shaved off using sharp scissors. The stump and appendix were each secured with two 2/0 Vicryl knots, but the mesoappendix required two or more knots.

Intracorporeal Knotting (Group-B):

Twenty centimeters of 2/0 Vicryl suture was utilized for the intracorporeal knotting procedure. At the appendix's base, three knots were tied using a hybrid of square and surgeon's knots. With the valve held open, the appendix was collected through the port after it was removed. If necessary, a drain was implanted, and peritoneal lavage was carried out. To make sure there was no bleeding and that everything was safe, the laparoscopic camera was used to examine the cecum and stump. Histopathological analysis was performed for all specimens. The procedure for knot installation was identical to that of the ECK group. Each procedure's time was meticulously noted, along with any complications that arose during surgery.

Surgical technique:

A supra-umbilical incision was used to produce pneumoperitoneum, either openly or using a closed method. An intra-abdominal pressure of 12–14 mmHg was maintained with the use of carbon dioxide insufflation. Once the pneumoperitoneum procedure was successfully completed, a 30º 10mm telescope was inserted through the umbilical port. The procedure involved a trio of ports: one 10 mm camera port, one 5 mm working port located 4-5 cm above the pubis, and a third 5 mm port on the left side of the body, medial to the left anterior superior iliac spine.

The diagnosis was verified after the appendix was located in the right iliac fossa. After mobilizing the appendix, it was maintained in place with an atraumatic grasper as traction was applied to the anterior abdominal wall. We used both blunt and sharp dissection tools to break down the adhesions. Using a combination of coagulation and cutting electro-cautery, the mesoappendix was cauterized using unipolar diathermy, working its way from the tip to the base. A harmonic scalpel served the identical function in a couple of instances.

Primary outcome:

The measure was the time taken to complete each procedure.

Secondary outcome:

Measures the number of mistakes made during knot tying, knot strength, and the ability to spread the knot.

Follow-Up:

All patients were monitored during their hospital stay and postoperatively at 1-week, 2-week, and 1-month intervals in the outpatient clinic. Any postoperative complications were noted. Additionally, an abdominal and pelvic ultrasound was performed before discharge. A comparative analysis between the two groups was performed to evaluate operative time, surgical difficulties, intraoperative and postoperative complications, hospital stay duration, and time to return to daily activities.

Ethical considerations:

The study was approved by the Research Ethics Committee of Al-Azhar University, Faculty of Medicine, Cairo, Egypt. Informed written consent was obtained from all patients prior to enrolment.

Statistical Analysis:

Software developed by IBM and published in Armonk, New York, USA, SPSS v27, was used for carrying out the statistical analysis. We used an unpaired Student's t-test to compare the two groups for quantitative data, which were given as means and standard deviations (SD). When applicable, the Chi-square test or Fisher's exact test was used to analyse qualitative variables, which were provided as percentages and frequencies. A two-tailed P-value<0.05 was used to determine a statistically significant result.

3. Results

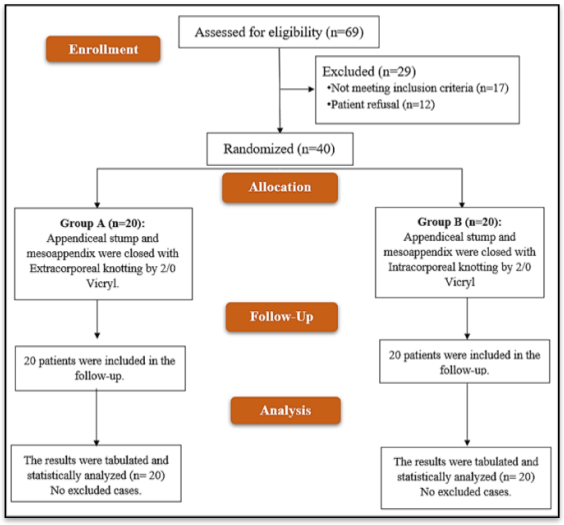

Figure 1. CONSORT flowchart of the enrolled patients.

Table 1. Baseline characteristics of the studied groups.

		GROUP-A (N=20)	GROUP-B (N=20)	P-VALUE
AGE (YEARS)	Mean± SD	35.6±10.52	32.7±8.67	0.347
	Range	20-47	21-52	
SEX	Male	13(65%)	9(45%)	0.203
	Female	7(35%)	11(55%)	
WEIGHT (KG)	Mean± SD	78.3±15.41	80.95±11.85	0.546
	Range	50-96	64-96	
HEIGHT (M)	Mean± SD	1.66±0.05	1.65±0.05	0.617
	Range	1.58-1.75	1.56-1.74	
BMI (KG/M^2)	Mean± SD	28.49±5	29.92±4.72	0.358
	Range	19.29-36.2	21.38-37.04	
ASA PHYSICAL STATUS	ASA I	15(75%)	17(85%)	0.429
	ASA II	5(25%)	3(15%)	

BMI:body mass index, ASA:American Society of Anesthesiologists.

The baseline variables (age, sex, height, weight, BMI, and ASA physical status) did not significantly differ between the two groups, (table 1).

Table 2. Comorbidities of the studied groups.

	GROUP-A (N=20)	GROUP-B (N=20)	P-VALUE
DM	9(45%)	8(40%)	0.749
HTN	11(55%)	13(65%)	0.518
DYSLIPIDEMIA	7(35%)	10(50%)	0.337

DM:diabetes mellitus, HTN:Hypertension.

Diabetes mellitus, hypertension, and dyslipidaemia (in post operative follow up),were among the related comorbidities that did not substantially differ between the two groups, (table 2; figure 2).

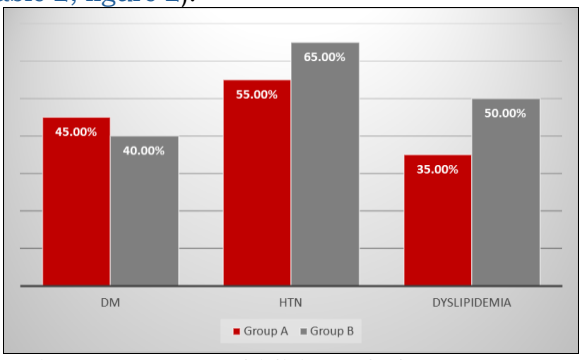

Figure 2. Comorbidities of the groups under study.

Table 3. Operative data of the groups under study.

		GROUP-(N=20)	GROUP-B(N=20)	P-VALUE
OPERATIVE TIME (MIN)	Mean± SD	47.35±10.97	62.55±11.23	<0.001*
	Range	30-65	44-75	
DRAIN INSERTION		6(30%)	3(15%)	0.450
CONVERSION TO OPEN PROCEDURE		0(0%)	0(0%)	---
INTRAOPERATIVE BLEEDING		2(10%)	1(5%)	0.548

*: p-value <0.05 indicates statistical significance.

According to the operative data, group-A's operative time was substantially less than group-B's (47.35±10.97 min vs. 62.55±11.23 min, P<0.001). In terms of intraoperative bleeding and drain insertion, there was a negligible difference between the two groups. None of the cases in either group that were examined underwent the conversion to open procedure, (table 3; figures 3&4).

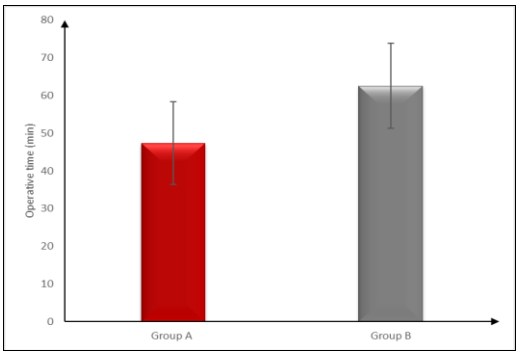

Figure 3. Operative time of the groups under study.

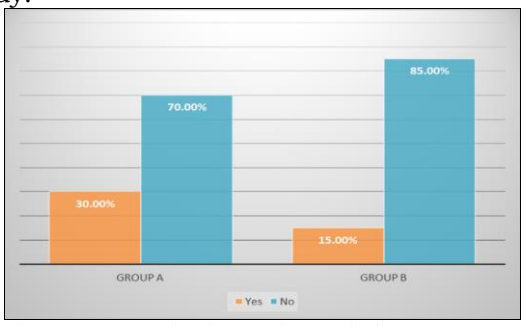

Figure 4. Drain insertion of the groups under study.

Table 4. Hospital stay of the groups under study.

		GROUP-A (N=20)	GROUP-B (N=20)	P-VALUE
HOSPITAL STAY (DAYS)	Mean± SD	1.85±0.81	2.05±0.76	0.426
	Range	1-3	1-3	

The difference between the two groups' hospital stays was negligible, (table 4; figure 5).

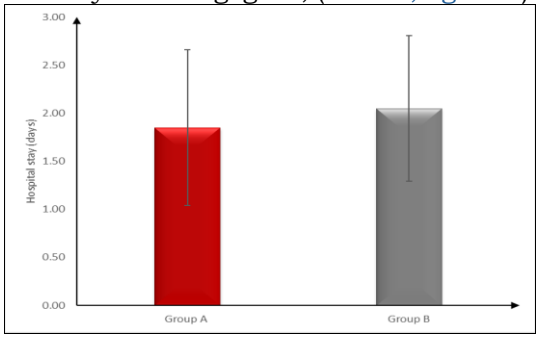

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Figure 5. Hospital stay of the groups under study.

Table 5. bowel noises returning after surgery and the study groups beginning to feed.

		GROUP-A (N=20)	GROUP-B (N=20)	P-VALUE
POST-OPERATIVE RETURN OF INTESTINAL SOUNDS & START FEEDING (HOURS)	Mean± SD	15.25±2.61	16.75±3.93	0.164
	Range	10-19	10-22	

There was no discernible difference between the two groups' post-operative intestinal sound returns and feeding initiations, (table 5; figure 6).

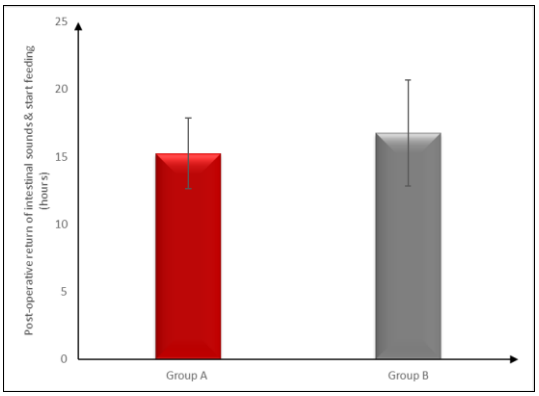

Figure 6. Return of intestinal sounds following surgery and the initiation of meals in the groups under study

Table 6. Postoperative complications of the studied groups.

	GROUP-A (N=20)	GROUP-B (N=20)	P-VALUE
SUPERFICIAL WOUND INFECTION	1(5%)	3(15%)	0.291
POSTOPERATIVE DELAYED PERISTALSIS	1(5%)	1(5%)	1.00
INTRAABDOMINAL ABSCESS	0(0%)	1(5%)	0.311
FECAL FISTULA	0(0%)	0(0%)	---
BLEEDING	0(0%)	0(0%)	---
PORT SITE HERNIA	0(0%)	0(0%)	---

Among the postoperative complications, one patient in group A and three in group B experienced superficial wound infection (5% and 15%, respectively), one patient in group A and one in group B experienced postoperative delayed peristalsis (5% and 5%, respectively), and only one patient in group B experienced intraabdominal abscess. None of the patients in either group experienced bleeding, port site hernias, or fecal fistulas. The postoperative complications did not significantly differ between the two groups, (table 6; figure 7).

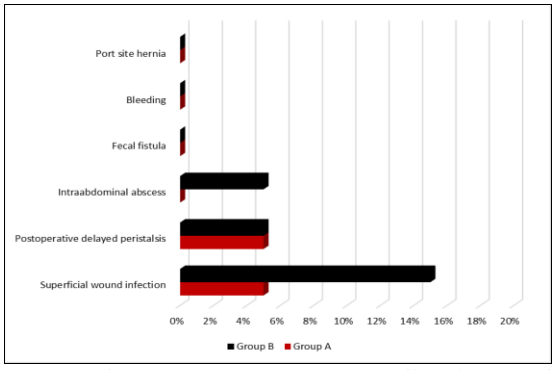

Figure 7. Postoperative complications of the studied groups.

4. Discussion

Because laparoscopic appendectomy has so many advantages over open surgery, it is now the standard procedure for treating acute appendicitis, one of the most prevalent surgical emergencies in the world. These include fewer

wound infections, shorter hospital stays, quicker healing, less pain following surgery, and better cosmetic results.[7]

The results of the present study were consistent with MAHMOUD et al.[8] We sought to compare the Intracorporeal Knot (ICK) and Extracorporeal Sliding Knot (ECK) in terms of ligating the appendix base during laparoscopic appendectomy. Thirty patients with acute appendicitis were split into two equal groups for this prospective randomized comparative study: Group I received an extracorporeal sliding knot (15 instances), and Group II received an intracorporeal knot (15 cases). According to their findings, the ECK group's mean age was 29±5.10 years, while the ICK group's was 29.33±5.39. The ECK group had nine males (60%) and six females (40%), whereas the ICK group had seven males (46.7%) and eight females (53.3%). Regarding age and gender, no statistically significant difference between the two study groups was discovered.

Additionally, this study's findings were in line with Elshoura et al.,[9] We sought to confirm the efficacy of intracorporeal suture, endostapler, and extracorporeal sliding knot stump closure in various appendicitis stages. This prospective clinical trial included 139 individuals in total. A suture knot was used in group B after the extracorporeal knot's planned closure of the appendicular stump failed twice due to appendicular base necrosis. Group A consisted of 45 patients, of whom 27 (60%) were men, and 18 (40%) were women. With a range of 10–62 years, their average age was 33.5±13.6 years. Group B consisted of 43 patients, 24 of whom were men (55.7%) and 19 of whom were women (44.2%). They ranged in age from 11 to 58, with a mean age of 36. Group-C consisted of 47 patients, of whom 21 (44.7%) were men, and 26 (55.3%) were women. They were between 13 and 63 years old, with an average age of 33.6±14.5 years. The age and sex distributions of the groups did not differ statistically significantly.

The two groups did not differ statistically significantly in the related comorbidities, such as diabetes mellitus, hypertension, and dyslipidaemia.

The current study's findings were corroborated by Aziz et al.,[10] who aimed to match the extracorporeal knot-tying join with metallic endoclips in LA stump closing in terms of complications, surgical period, hospitalization, and cost. The cases have been allocated to two identical groups: group 1 has been exposed to the extracorporeal knotting group (30 cases), and group 2 has been exposed to the metallic endoclip (30 cases). When comparing Group A and Group B for the presence of diabetes mellitus, hypertension, and smoking, they found no statistically significant differences.

Group A had a considerably lower operating duration than group B when it came to the operative data (47.35±10.97 min vs. 62.55±11.23 min, P<0.001). Drain insertion and intraoperative hemorrhage were not significantly different between the two groups. No instances in either group underwent a change to an open procedure.

Similarly, the findings of this study were in agreement with Elshoura et al.,[9] proved that the average time it took to complete all procedures was 70.9 minutes, with a range of 30-125 minutes. In terms of average operation time, there was a noticeably different pattern between the two groups (P<0.05). Group A had an average operation time of 56.4 minutes (ranging from 30-85 minutes), while group B had an average operation time of 71.5 minutes (ranging from 40-90 minutes).

As well, the results of this study, were in line with Pollakan,[11] who aimed to compare the outcomes in terms of length of hospital stay (LOS), operative time, time to resume a soft diet, frequency of intravenous opioid administration, and postoperative complications following laparoscopic appendectomy (LA) versus open appendectomy (OA) in patients with acute appendicitis. The addition compares the effectiveness outcomes of the laparoscopic extracorporeal appendectomy (LEA) and laparoscopic intracorporeal appendectomy (LIA) technique. In the laparoscopic technique, the median operative time for LEA was shorter than LIA [LEA 35 (IQR 15) min versus LIA 50 (18.7) min, p< 0.001].

We found no statistically significant difference in the length of time patients spent in the hospital between the two groups in this study.

The present study's findings were consistent with those of Elshoura et al.,[9] revealed that, on average, patients spent 1.94 days in the hospital (with a range of 1-12 days). This included 1.73 days for group A and 1.8 days for group B. Group A and group B were found to be statistically indistinguishable (P=0.6).

The same holds true for the validity of our study by MAHMOUD et al.,[8] who did not find a statistically significant distinction (p>0.05) in the patient duration of stay between the two groups.

In addition, Ureyen et al.,[12] contrasted open appendectomy with laparoscopic appendectomy using intracorporeal knot-tying and glove endobag procedures with relation to length of hospital stay and discovered no statistically significant differences.

Furthermore, Aziz et al.,[10] found that patients in the endoclip group spent an average of 30.26±27.04 hours in the hospital, whereas those in the extracorporeal knot group spent an average of 23.15±12.72 hours. The duration of

hospitalization did not show a statistically significant variation.

When comparing the two groups at the present time, we found no statistically significant difference (p=0.164) in the timing of the return of intestinal sounds after surgery and the beginning of oral feeding.

Furthermore, the current study's findings were consistent with those of Elshoura et al.,[9] proved that no complications occurred during the procedure, no cases were moved to an open approach, and no mortalities occurred. The overall incidence of problems following surgery was 4.4%. Three instances (one with an intra-abdominal abscess, one with a wound infection, and one with an ileus) constituted group A's 6.6% complication rate. There was one laparoscopy due to an intra-abdominal abscess, bringing the complication rate in group B to 2.3%.

Furthermore, Azi et al.,[10] found no statistically significant difference between the groups with respect to intraoperative and postoperative problems.

Limitations: This study had a small sample size of only 40 patients, which may limit the generalizability of the results. It was also conducted at a single center, and long-term follow-up was not performed to assess delayed complications.

4. Conclusion

Extracorporeal and intracorporeal knot-tying techniques in laparoscopic appendectomy are both safe and effective. However, extracorporeal knotting was associated with a significantly shorter operative time. In terms of complications and postoperative recovery, the two methods were statistically indistinguishable.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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