# Extracorporeal knot-tying suture versus metallic endoclips in laparoscopic appendicular stump closing in uncomplicated acute appendicitis

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**Background**
Laparoscopic appendectomy (LA) is a popular operative procedure. But, worries still exist concerning if the appendicular stump closing must be performed with a clip, an end loop, or other methods.
**Aim**
The aim of the study was to match the extracorporeal knot-tying join with metallic endoclips in LA stump closing in terms of complications, surgical period, hospitalization, and cost.
**Patients and methods**
The current work was a prospective randomized comparative study that included 60 cases who visited the general surgery department in Rabia Hospital in KSA, the patients with appendicitis have been treated by LA between March 2020 and March 2021. The cases have been allocated to two identical groups: group 1 has been exposed to extracorporeal knotting group (30 cases) and group 2 was exposed to the metallic endoclip (30 cases).
**Results**
Intraoperative and postoperative complications in the studied groups have no statistical difference. However, the frequencies of the complications were slightly higher in the endoclip group compared with extracorporeal knotting group.
**Conclusion**
Based on the obtained results from the present study, we concluded that closing the appendicle stump with extracorporeal knotting and metallic endoclip in patients who undergo LA was not different according to postsurgical complications and hospitalization period, but the frequencies of the complications were slightly higher in the endoclip group compared with extracorporeal knotting group. The two approaches can be utilized, depending on the surgeon's view with no expected statistically significant change in the findings.

**Keywords:**
appendectomy, complication, endoclips, extracorporeal knot, laparoscopic

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## Introduction

Laparoscopic appendectomy (LA) is presently a well-known and extensively used surgical procedure. It had many advantages in comparison with open surgeries, involving fewer pains in the postoperative interval, earlier restoration of the normal activities and work, shorter hospitalization periods, and lesser percent of infections of wound [1].

Suitable closing of the appendix stump is extremely significant to prevent considerable complications like postoperative peritonitis, fistula, and sepsis. Throughout LA, many adjustments with novel materials were presented to optimize and control the appendicle stump closing involving endoloop, Ti clips, staplers, nonabsorbable polymer-made clips (hemolock clips), handmade loops, suture closing via additional–corporeal sliding knots, or intracorporeal knot ligation [2].

Intraabdominal knot tying using laparoscope is very hard because of inadequate spaces for movement, deficiency of rotation movements at the wrist joints, the fulcrum for motion because of extended instruments, is far from the wanted location, and it as well needs high manual skill [3].

One of the most significant stages in appendectomy is the satisfactory appendicle base closing. When doing open appendectomy, the stump closing afterward will be buried in the cecum using a purse cord join to decrease the probabilities of intraabdominal infections. Subsequently, it was established that stump burial/ inversions had no significant influence on the

results, but the procedure still is employed by several surgeons [4].

Appendix base closing is a conclusive stage in the occurrence of intraabdominally postoperative infections, fecal sinuses, and surgical-site infection (SSI) in the case of open as well as in LA. This directed carefully surgeons to burry or invert the appendicle stump into cecum thereafter tying in patients with base inflammations, throughout repetitive inversions that had not been confirmed to have greater outcome. Base closures are very significant in LA as the early experiences revealed that LAs have elevated intraabdominal occurrence of infections – particularly in patients with perforated appendicitis – and owing to the accessibility of various methods of base closing [5].

Although the LA procedure was well-known, worries and disagreement present concerning the appendicular stump closing, which is a core object in the operation. Consequently, many alterations to the original method using novel constituents were presented to optimize and control the appendicular stump closing, like the endoloop, dual endoloop, ultrasonically stimulated scalpel, instrumentally supported knotting, bipolar coagulation, slip-knot tie, metallic clips, hemo-lok polymer clips, and linear endostaplers [6].

Closing of the appendicle stump is a vital stage in LA, and its unsuitable managements could cause disastrous complications. Various procedures were defined to secure the appendicle base in LA, and in spite of several investigations, there was not general contract on any technique. The inherent drawbacks of laparoscopically intracorporeal knot tying are inadequate movement space, reduced sensations of the employed tension to the tissue, and difficulties in making the knot owing to technical necessities. On the other hand, extracorporeal knots are simpler to make, and the surgeons controlled the tensions. The mainstream of extracorporeal knots is sliding knots, and this increase worries around the security of the strings. Because of many challenges and problems to intracorporeal knot tying, the surgeon tries to dodge intracorporeal closing and does utilize the extracorporeal method [7–9].

In this work, we aimed to find if there are any significant differences in the closure's efficacy of extracorporeal knot (Roeder's knot) and metal endoclips mainly concerning infectious risks and other complications and then concerning the economic, surgical period, and hospitalization.

## Patients and methods

The current work was a prospective comparative randomized study involving 60 cases, participated from the General Surgery Department in Rabia Hospital in KSA, the cases with appendicitis and were managed by LA between March 2020 and March 2021. The cases have been allocated into two identical groups: group 1 has been exposed to the extracorporeal knotting group (30 cases) and group 2 was exposed to the metallic endoclip (30 cases). The ethical approved for the study fro the hospital scientific committee was obtained (Rabiah hospital). Informed signed consent was obtained from every patient.

All cases have been detected with acute appendicitis based on clinical criteria, ultrasound scans and laboratory. The findings (Alvarado scoring ≥8–10): the cases with perforations of appendix, diffused and localized peritonitis, crumbly appendix base, sign of pelvic inflammatory disorder, conversions to open surgeries, and probably other diagnoses were omitted from the investigation. All cases were managed by a qualified surgeon in minimally access surgeries with more than 10-year experiences in laparoscopic operations.

The data sheets were made and filled for every case thereafter receiving the agreement. As well as demographics, it comprised variables of two intraoperative – blood loss and organ injuries – and five postoperative complications – postoperative ileus, intraabdominal infections, SSI, readmissions, and reoperations.

### Surgical technique

All of the patients were managed under complete anesthesia and a similar antibiotic – intravenous ceftriaxone – and similar skin preparations – povidone iodine solution 10%. In total, three ports have been utilized in all patients with a single infraumbilical camera port and two further ports – a port in the hypogastrium and a port in the abdominal right side. The abdomen space was primarily checked and preoperative diagnosing of the inflamed appendix has been established. The appendix base has been emptied out via dividing the mesoappendix.

For the extracorporeal knot group, the appendix base has been tied using vicryl 0 (Ethicon Vicryl-Plus) (Johnson and Johnson Co, Raritan, New Jersey, USA) with two knots placed 0.5 cm far and the appendix was cut in-between the two knots. The knots sort was a Roeder's knot with a half-hitch

tailed by three complete circles and last tailed by an interlocking half-hitch. Then the knot was pushed by the aid of a tight pusher till it cozily tautened around the base of the appendix.

For the metal endoclip group, three metal endoclips (Ethicon Liga-clips, Ti-Clips Cartridge – medium large or large sizes) were utilized for base closure, with two closers to the base, apposing each other and the third 0.5 cm far, and the appendix has been separated by the higher two clips. The appendix was carried out by the hypogastric port and irrigations by saline of about 500–1000 ml have been performed.

The skin cuts were locked via 2/0 prolene suture and mepore dressing was utilized.

All cases received a similar antibiotic treatment – oral cefixime – for 5–7 days and called for following up at day eight to the 12th day postoperatively for following up and stitch elimination. The antibiotics courses selected were built on the institutional routines.

Case data involving clinical history, physical examinations, essential symptoms, white blood cell count, radiograph of the chest and abdomen, ultrasound results, procedure details, operational period, preoperative and postoperative complications, causes for open-surgery conversions, hospitalization period (days), mean following-up period (months), and postoperative consequences have been assessed and tabulated for analyzing.

### Statistical analysis

The collected data were analyzed via the Windows-based SPSS-22.0 (IBM Corp., Armonk, New York, USA). The continuous variables are presented as mean ±SD, and categorical variables are presented as numbers and percent. Normality for continuous variables was tested via the Shapiro–Wilk testing, which showed that the continuous variables exhibited normal distributions ($P>0.05$). The unpaired $t$ testing was utilized to compare variables in the studied groups. For statistical assessment of categorical variables, the $\chi^2$ testing and Fisher exact testing have been utilized. A $P$ value less than 0.05 has statistical significance.

## Results

In this study, there were 60 patients, those were divided into equal groups: 30 patients for extracorporeal knot tying (group 1) and 30 patients using metallic endoclips (group 2) in laparoscopic appendicle stump closure in acute appendicitis.

Table 1 shows that demographic data regarding age, sex, and BMI were similar in the studied groups with statistically no significant change. The surgical period was significantly higher in the extracorporeal knot group compared with the endoclip group. The mean hospitalization of cases in the extracorporeal knot group was 23.15±12.72 h and in the endoclip group, 30.26±27.04 h. A nonsignificant change was found regarding hospitalization period.

**Table 1 Demographics and clinical characteristics**

| | Extracorporeal knotting (*N*=30) | Metallic endoclip (*N*=30) | *P* |
|---|---|---|---|
| Age (years) | | | |
| Mean±SD | 27.14±6.53 | 25.35±5.12 | 0.242 |
| BMI (kg/m$^2$) | 27.48±3.65 | 26.71±3.82 | 0.428 |
| Sex [*n* (%)] | | | |
| Male | 18 (60) | 16 (53.3) | 0.602 |
| Female | 12 (40) | 14 (46.7) | |
| Surgical period (min) | | | |
| Mean±SD | 49.22±8.64 | 43.67±7.48 | 0.010* |
| Hospitalization (h) | | | |
| Mean±SD | 23.15±12.72 | 30.26±27.04 | 0.198 |
| Comorbidities [*n* (%)] | | | |
| DM | 3 (10) | 4 (13.3) | 0.688 |
| HTN | 2 (6.7) | 2 (6.7) | 1 |
| Smoking | 12 (40) | 11 (36.7) | 0.791 |

DM, diabetes mellitus; HTN, hypertension. *Shows that demographic data regarding age, sex, and BMI were similar in the studied groups with statistically no significant change. The surgical period was significantly higher in the extracorporeal knot group compared with the endoclip group. The mean hospitalization of cases in the extracorporeal knot group was 23.15±12.72 h and in the endoclip group, 30.26 ±27.04 h. A nonsignificant change was found regarding hospitalization period.

**Table 2 Intraoperative and postoperative complications**

| | Extracorporeal knotting (*N*=30) [*n* (%)] | Metallic endoclip (*N*=30) [*n* (%)] | *P* |
|---|---|---|---|
| Intraoperative complications | | | |
| Bleeding | 1 (3.3) | 2 (6.7) | 0.554 |
| Organ injury | 0 | 1 (3.3) | 0.315 |
| Postoperative complications | | | |
| Postoperative ileus | 2 (6.7) | 3 (10) | 0.640 |
| Intraabdominal infection | 1 (3.3) | 2 (6.7) | 0.554 |
| Wound infection | 3 (10) | 5 (16.7) | 0.448 |
| Readmission | 1 (3.3) | 1 (3.3) | 1 |
| Reoperation | 0 | 1 (3.3) | 0.315 |

Table 2 shows that the intraoperative and postoperative complications in the studied groups have no statistical difference. However, the frequencies of the complications were slightly higher in group 2 compared with group 1.

One patient in group 1 and two patients in group 2 suffered from intraoperative bleeding. Three patients develop postoperative intraabdominal infection and readmitted in the hospital, one patient in group 2 needs reoperation for drainage of the abscess. The other two patients were managed conservatively. The same three patients also developed wound infection and managed by wound care and repeated dressing.

## Discussion

Laparoscopy appendectomy surgeries are increasing daily because of its facilities and benefits like lesser postoperative pains, faster recovery, faster hospitalization, less postoperative complications, and minimally sized incisions/scars. The principal anxiety in LA is the matter of appendicular stump closing or base. Therefore, many methods have been recommended and examined for its closure, some of these methods include endoloop, double endoloop, cutting with an ultrasonic knife, tying with an instrument, metal or plyometric clips, ligator and thread, hemolock, and linear endostapler [10].

A satisfactory appendicular stump closing is essential for minimizations of intraabdominal and SSIs. Several methods were existing for the appendix-base closing, whereas doing a LA like endoloops, clips, knots, and stapler [6,11].

There are different techniques for appendix stump closure in laparoscopic surgery. Some authors recommend simple tie knotting or endoloop, whereas others recommend staplers and clips. All these techniques were proven to be safe and effective, but stapler and endoloop increase the cost, especially stapler should be preferred only in selected patients. Metal clips were found to be effective and safe even in complicated appendicitis [6].

Extracorporeal knotting is a substitute method extensively utilized. To utilize extracorporeal sliding knots, the way is to perform the knots out of the body and then sliding it inside to do the purpose. The knots done should be secured as the traditional knots, rapid and simple to do [3].

The endoloop is a commercial product that is generally utilized in LA. It could be manufactured of polyglactin or vicryl, and may be of several widths. Using endoloops were supposed by several researchers due to their safety in the appendix stump closure and economy in comparison with staplers [12].

An insufficient appendicular stump closing may cause intraabdomen SSIs. There are many methods for appendix base closing when doing a LA like endoloops, clips, knotting, and staplers. In this study, we aimed to find if there are any significant differences in the closing efficacy of extracorporeal knotting and metal endoclips mainly according to infectious risk and further complications then in economy, surgical period, and hospitalization.

In the present study, we found that demographic data regarding age, sex, and BMI were similar in the studied groups with a nonsignificant change. The surgical period was significantly higher in group 1 compared with group 2. The mean hospital stay of cases in group 1 was 23.15±12.72 h and in group 2, 30.26±27.04 h. A nonsignificant change was found regarding hospitalization.

In agreement with our results, the study of Nadeem *et al.* [9], was conducted on a number of 68 cases, group 1 had 36 (52.9%) cases and group 2 had 32 (47.1%)

cases. The cases' mean age in group 1 was 24±7.78 years and in group 2, 23.0±7.30 years. A nonsignificant change was found in ages ($P$=0.9) but the two groups have a significant change ($P$=0.008) regarding sex.

Another study of Arakeeb *et al.* [13], reported the demographic features of their work groups: the mean age of the extracorporeal knotting group was 29±5.10 years, in comparison with 29.33±5.39 in the intracorporeal knot group. There were nine (60%) men and six (40%) women in the extracorporeal knotting group, whereas there were seven (46.7%) men and eight (53.3%) women in the intracorporeal knot group. Between the women cases, there were two gravid, one in every group in the 18th and 20th week of pregnancy, respectively. The mean BMI of the extracorporeal knotting group was 25.45±2.76 kg/m$^2$ in comparison with 26.68±2.94 kg/m$^2$ in the intracorporeal knot group, a nonsignificant change was existing regarding ages, sex, and BMI among the studied groups.

Furthermore, in the study by Sadat-Safavi *et al.* [10], 76 patients underwent LA who were randomized and allocated to two groups, and no one of the cases were omitted during the study. The endoclip group was 38 cases (18 males, 20 females; mean age 22±3.69 years), and the endoloop group was 38 cases (16 males, 22 females; mean age 24.26 ±5.99 years). Overall, based on the findings of our work, the mean age of all cases was 23.13±5.07 years and 44.7% of the cases were males. There were nonsignificant changes among the studied groups regarding ages and sex ($P$>0.05).

Appendicular stump closing is the most contentious problem in the LA technique. In spite of the fact that several researchers have defined many adjustments with novel materials for appendicular stump closing, the best closing material has not yet been defined. Furthermore, the majority of these materials can extend the surgical period or rise the costs that can restrict the LA popularity [14].

In the current study, the intraoperative and postoperative complications in the studied groups have a nonstatistical difference. However, the frequencies of the complications were slightly higher in group 2 compared with group 1.

Our results are supported by the study of Nadeem *et al.* [9], in which the intraoperative and postoperative complications in the studied groups have a nonstatistical difference. In total, two cases in group 2 had suffered blood loss complication versus a single case in group 1. These same cases lately suffered from an intraabdominal infection and were readmitted and one case in group 2 reoperated for abscess draining. The postoperative complications were faced by ileus and wound infections. Notable between others is the surface SSIs that were analogs in the studied groups.

Gonenc *et al.* [15], in their investigation concluded an occurrence of 1.6% in the clipping arm and 4.3% in the intracorporeal knotting arm. Beldi *et al.* [16], in their retrospective report have concluded a rate of ileus of 0.7% with stapler closing and 0.5% with endoloops. No ileus occurrence was stated thereafter; further corporeal knotting was observed in reports by Di Saverio *et al.* [17] and Arcovedo and Barrera [18].

Arakeeb *et al.* [13] reported that there was a highly significant change regarding the surgical period among the studied groups. extracorporeal knotting group had a faster surgical period in comparison with intracorporeal knot group. Surgical period was 46.07±11.70 mins in the extracorporeal knotting group in comparison with 61.73±11.33 mins in the intracorporeal knot group with $P$=0.001. Additionally, surface wound infections advanced in a single case (6.7%) in the extracorporeal knotting group and two (13.3%) cases in the intracorporeal knot group, as well as every group has a single case (6.7%) with postoperative late peristalsis, but concerning intraabdominal abscess, there was a single case in the intracorporeal knot group who has postoperative abscess in the RIF. Moreover, no cases suffered from fecal fistula, blood loss, or port-site hernia. There was a nonsignificant change among the studied groups regarding postoperative complications.

Elshoura and Hassan [19] revealed that the mean surgical period of extracorporeal knotting group was 71.5 mins (range: 40–90 min), and of intracorporeal knot group was 84.3 mins (range: 45–125 min), although the mean surgical period was 56.4 mins in the endostapler group. They utilized the post-hoc testing that revealed significant changes regarding surgical period among the studied groups: among endostapler group and extracorporeal knotting group ($P$=0.01), among endostapler group and intracorporeal knot group ($P$=0.02), and among extracorporeal knotting group and intracorporeal knot group ($P$=0.004).

In contrast, Arer *et al.* [20] concluded that the average hospitalization for group 1 was 1 day and for group 2

was 1 day ($P$=0.038). The permanent pathology of 12 (11.1%) patients in group 1 and eight (4.5%) cases in group 2 was stated as perforated appendicitis ($P$=0.053). Superficial incisional SSI (4.5%) was the commonest complication that was observed in 13 patients. General postoperative rate of complications was 6.6% ($n$=19). No patients received surgical reintervention. Percutaneous intraabdominal abscess drainage was done in four (1.4%) patients. No intraoperative complication and postoperative mortality was observed.Delibegovic *et al.* [14] also examined animal samples and confirmed that by the usage of endoloop to close the appendicle stump is more efficient than using clips, in another RTC of Caglià *et al.* [21], 35 patients underwent LA using endoloop and a total of three cases were affected by complications and the mean hospitalization period was also 2 days. The hospitalization period was 1.6 days in our study, which is a bit lesser than the mentioned study, but no serious complications were seen after or during the surgery, one patient of infection and one patient of the clips falling off. Another study of Arash *et al.* [22] examined 242 patients who had undergone LA and indicated that endoloop is efficient and safe, especially in cases where the perforation is highly likely to occur; this method also proved to be safe in our study.

In our study, metal endoclip and extracorporeal knotting are two hopeful methods to secure the appendix stump in LA with identical rates of complication. Metal endoclips have higher cost in comparison with extracorporeal knotting, but have quicker surgical periods. Owing to the easiness of methods, we confidently recommended utilization of the endoclip particularly by surgeons who learned laparoscopic techniques. Whereas, more qualified surgeons in poor setups and surgeons attempting to improve their technical abilities must opt for extracorporeal knotting.

## Conclusion

Generally, based on the obtained results from the present study, we concluded that closing the appendicle stump with extracorporeal knotting and metal endoclip in patients who undergo LA was not different in terms of postsurgical complications and hospitalization period, but the frequencies of the complications were slightly higher in the endoclip group compared with the extracorporeal knotting group. The two methods can be utilized, depending on the surgeon's view with no expected statistically significant change in the findings. However, it is recommended to study this subject with larger samples to obtain more reliable and valid results.

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**Conflicts of interest**

There are no conflicts of interest.

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