

Comparison of Extracorporeal Knot Tying Versus Metallic Endo-Clip in Laparoscopic Appendiceal Stump Closure in Patients with Uncomplicated, Acute Appendicitis

Extracorporeal Knot Versus Metallic Endo-Clip in Laparoscopic Appendiceal Closure

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ABSTRACT

Objective: To explore the significant difference between metallic endo-clips and extracorporeal knot (Roeder's knot) majorly in terms of infection risks, hospital stay, operative time, and cost.

Study Design: A randomized control trial study

Place and Duration of Study: This study was conducted at the Department of Surgical Unit, Lahore General Hospital Lahore from 9th May 2020 to 9th May 2021.

Materials and Methods: After passing through inclusion and exclusion criteria, the patients were randomly categorized into two groups: Group A comprised of patients operated with metallic endo-clip technique and Group B was the extracorporeal knotting group. Following the surgeries in both groups, the data including demographics, hospital stay, surgery duration, overall cost, and postoperative complications were collected. SPSS 19 was used for statistical analysis and a P-value less than 0.05 for any variable was considered statistically significant.

Results: A total of 60 patients were categorized such that 32 (53.3%) were placed in group A and 28 (46.6%) in group B. The two groups didn't show a significant difference in terms of patients' age and their hospital stay ($p > 0.05$). However, the mean surgical time for group A was shorter when group B (39 vs 41 mins, $p = 0.03$). Moreover, extracorporeal knotting was economical (280 PKR) as compared to endo-clips (900 PKR). Among postoperative complications, the incidence rate of bleeding, postoperative ileus, intra-abdominal infection, and readmission rate was significantly higher in an endo-clip group.

Conclusion: Although, the use of endo-clips saves operative time but is costly as compared to extracorporeal knotting. The higher rate of complications reported in the former group is perceived as independent of the technique used. Therefore, both of the groups can be considered equally safe. However, given the simplicity of technique, we recommend the use of metallic endo-clips for beginners.

Key Words: Laparoscopic appendectomy, extracorporeal knotting, metallic endo-clips, appendix base closure, acute appendicitis.

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INTRODUCTION

Acute appendicitis is the most frequent reason behind intra-abdominal operative emergencies¹ and therefore

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appendectomy is found to be the most common operative procedure performed in all the surgical departments of the world². The technique of laparoscopic appendectomy was first introduced 3 decades ago³. With the advancement in cutting-edge technology, it has evolved as an established operative procedure that offers minimum pain, early recovery, and quicker improvement in quality of life^{4,5}. This technique is usually preferred in obese, females and those patients who couldn't be diagnosed accurately⁶. During appendectomy, the proper closure of the appendiceal stump is considered a critical step. In open appendectomy, the stump used to be buried in the caecum following the closure through purse-string suture to ameliorate the risk of intra-abdominal infection. Later on, it was found that this stump inversion doesn't significantly impact the outcomes but

the technique remains to be performed by a large number of surgeons⁶. Laparoscopic appendectomy is also surrounded by similar concerns and was associated with a higher risk of postsurgical intra-abdominal infection when compared to the open technique⁷. Many techniques such as extra-corporeal knotting, endo-loops, metallic endo-clips, intra-corporeal knotting, hem-o-lock clip, and endo-staplers have been in use for the closure of the appendix base during laparoscopic appendectomy. This comparison between these techniques has been assessed in different prospective and retrospective studies⁸⁻¹⁰; however, no technique is unanimously recognized as the most effective therapeutic methodology.

Laparoscopic appendectomy along with other laparoscopic procedures have always been in debate due to their large influence on healthcare expenditures. The overall cost of these techniques is multiplied when novel and expensive base closure procedures are performed. Thus, the experienced surgeons usually option for intra or extra-corporeal knotting for base closure and perceive them as safer for treating inflamed and friable bases¹¹. The novel techniques are, however, easy and quick to perform¹².

The metallic endo-clip technique was first introduced by Cristalli et al. in 1991 for the closure of the appendiceal stump¹³. The endo-clip is usually used to ligate cystic duct during laparoscopic Cholecystectomy and is a suitable alternative for appendix base closure¹⁴. So far, to the best of my knowledge, no sufficient studies have been conducted in Pakistan to compare the efficacy of all these procedures of base closure. This study aimed to explore the significant difference between metallic endo-clips and extracorporeal knot (Roeder's knot) majorly in terms of infection risks, hospital stay, operative time, and cost.

MATERIALS AND METHODS

A randomized controlled trial was conducted for the period of one year from 9th May 2020 to 9th May 2021 at the department of surgical unit in Lahore General Hospital Lahore. The patients diagnosed with acute appendicitis through clinical and laboratory evaluation and intended to undergo laparoscopic appendectomy were included in the study. Whereas, patients with the perforated appendix, diffuse or local peritonitis, inflammatory pelvic disease, and those who operated for any surgical procedure other than our study were excluded from the study. After seeking approval from Hospital Ethical Committee and informed consent from the participants, the patients were randomly classified into 2 groups: Group A: the metallic endo-clip, and Group B: extra-corporeal knotting. The data analyst was kept blinded for the procedural type. Following the selection criteria, 60 patients were included, out of which 32 were placed in Group A while 28 were in Group B.

The patients from both groups were operated on by experienced, certified surgeons. Similarly, all the patients were anesthetized similarly and were administered the same antibiotics (I/V ceftriaxone) and skin preparation (10% povidone-iodine solution). 3 ports, in hypochondrium, on the right side of the abdomen, and the supra umbilical with camera port were used in all the patients. Before beginning the surgical process, the abdominal cavity was investigated to reconfirm appendicitis. The mesoappendix was then dissected to clear the base of the appendix. For group A, 3 metallic end clips (Titanium Clip Cartridge in two sizes and Ethicon LigaclipsR) were applied such that two were close to the base in the opposing direction while the third was 5mm away. The appendix was cut between the first two clips and was brought out through a hypochondrium port. On the other hand, for group B, vicryl2/0 was tied with the base of the appendix with 2 knots (Roeder's knot), at the distance of 5mm, and the appendix was amputated between these 2 knots. Following appendectomy in both groups, all the incisions were closed through 2/0 proline sutures and a proper dressing was given.

At the end of the surgical procedure, a similar antibiotic course-oral cefixime for one week- was prescribed to all the patients, and follow-up and stitch removal was done between the 8th to 12th postsurgical days.

A self-designed data sheet was used for the collection of data which consisted of demographics, 2 intra-operative variables-organ injury and bleeding- and 5 postsurgical consequences-post surgical ileuses, infection at the surgical site, intra-abdominal infection, readmission in hospital, and reoperation. All the manually collected was analyzed using SPSS (version 19). Continuous data were compared between two groups through student's T-test while the comparison of categorical data was through Chi-square test. A P-value for less than 0.05 for any variable was considered statistically significant.

RESULTS

The study was based on 60 patients, where 32 (53.3%) were placed in the metallic endo-clip group (group A) and 28 (46.6%) were operated using the extra-corporeal knotting technique (group B) for base closure. There was no statistical difference in the mean ages of the two groups (24 vs 22, $p=0.89$). However, the sex ratio of the two groups was statistically different ($p=0.007$). The metallic endo-clip technique cost higher than extracorporeal knotting. The mean surgical time of Group A patients was 39 ± 7.5 against the time of 44.1 ± 8.6 in group B patients. Therefore, the procedural time was significantly lower in the endo-clipping technique than the knotting ($p=0.03$). No major difference was found in terms of the hospital stay of the patients in both groups ($p=0.2$). (Table I).

Among intra-operative complications, 3 patients in group A developed bleeding against 1 in group B ($p=0.04$). The same patients later complained of abscesses and were readmitted. One of these patients in the endo-clipping group had to be re-operated to remove the abscess. The incidence of postoperative ileus (3 vs 1 patient, $p= 0.04$) and intra-abdominal infection (2 vs 0 patients, $p=0.03$) was significantly higher in an endo-clipping group than extra-corporeal knotting group (Table 2).

Table No.I: Baseline Variables of the Study (N=60)

Variables	Group A, n=32 (53.3%)	Group B, n=28 (46.6%)	p-Value
Age (mean, SD)	24 \pm 7.2	22 \pm 6.68	0.89
Gender (male/female)	8/20	23/9	0.007
Cost (PKR)	900	280	-
Surgical time (minutes)	39 \pm 7.5	44.1 \pm 8.6	0.003
Hospital stay (hours)	28.2 \pm 19.5	20.3 \pm 13.2	0.2

SD: Standard deviation

Table No.2: Incidence of Intra-operative and Postoperative Complications in Two Groups (N=60)

Variables	Group A, n=32 (53.3%)	Group B, n=28 (46.6%)	P-value
Intra-operative complications (n, %)			
Bleeding	3 (9.3%)	1 (3.5%)	0.04
Organ Injury	1 (3.1%)	-	0.03
Post-operative complications (n, %)			
Postoperative ileus	3 (9.3%)	1 (3.5%)	0.04
Infection at the surgical site	3 (3.1%)	2 (7%)	0.07
Intra-abdominal infection	2 (6%)	0 (0)	0.03
Readmission	2 (6%)	1 (3.5%)	1
Reoperation	1 (3%)	0 (0)	0.45

DISCUSSION

Laparoscopic techniques have been widely used in diverse surgeries and appendectomy is one of them. Laparoscopic appendectomy has dominance open appendectomy in many aspects such as lesser pain, better imaging of the peritoneal cavity, and quicker recovery. However, factors such as longer surgical timing, costly instruments, and demand for technical expertise raise concerns about laparoscopic techniques¹⁵.

The technique adopted for closure of appendix stump plays a critical role in post-operative complications in both surgical methods for appendectomy. This has led to the introduction of various techniques and each of them has been found to have its pros and cons. This study has been designed to compare the most commonly used techniques for appendix base closure- metallic endo-clip and extra-corporeal knotting- in 3 major aspects, cost, operative time, and postoperative complications. Among both groups, a total of 4 patients developed unusual bleeding due to adhesions and cutting of mesoappendix while one of these cases also demonstrated cecal wall injury with serosal tear during dissection of adhered appendix away from the cecal wall. This serosal tear was repaired laparoscopically with suture vicryl 2/0. Following the removal of the drain, some of these patients revisited the hospital on the 8th day with the complaint of high fever and a CT scan revealed intra-abdominal collection. 1 of these patients had to be re-operated as the abscess was not resolving with an oral antibiotic course. Postoperative ileus and surgical site infections were also reported post-operatively but the incidence rate was significantly higher in end clipping group patients.

Two cases in the metallic endoclip group reported pre-operative intra-abdominal abscess. These patients were put on an antibiotic course and were managed conservatively. Since the leucocyte count remained in a range and the appendix base looked healthy, patients were operated on the 3rd day of hospital admission. However, postoperative ileus and collection of pus in the right iliac fossa were observed in a follow-up period of these patients. However, the complication was resolved by administering antibiotics, and reoperation was not required.

It was observed that the incidence of infection in both groups wasn't directly associated with the technique used but may be associated with pre-operative inflammation in the surgical area or dense adhesions. The complications reported in our study are comparable to the existing relevant literature. Our study reported ileus in 9.3% of cases in endo-clipping and 3.5% of patients in the knotting group. Whereas, Gonenc et al.⁽¹⁴⁾ reported incidence in endo-clipping (1.6%) than knotting group (4.3%). However, in studies conducted by Arcovedo et al.¹⁶ and Di Saverio et al.⁽¹¹⁾, no complication of ileus was reported by using the knotting technique. The high incidence rate in our study can be attributed to the comparatively smaller sample size. The rate in our study, however, remained significantly high in the endo clipping group. Similarly, a higher occurrence rate of surgical site infection is reported in our study when compared with previous studies^{12,17,18}. It could again be due to the limited sample size or might be possibly due to improper sterilization or postsurgical wound care. However, no significant difference was noted in the incidence of

wound infections between the two groups. Moreover, since all the surgeries were performed by expert surgeons, thus it removed the risk of performance bias in the study variables.

Our study was majorly limited in terms of smaller sample size and failure to conduct the double-blinded study as the data collectors were informed of the study groups and blinded investigators couldn't be arranged due to lack of funding. Usually, the sample size is based on study variables, for instance, risk of infection in our case, with the power of at least 80%, but these conditions would have extended our study period. Although, the smaller sample size of our study lowered the power, the sample size is still comparable to related studies conducted in different countries^{11,19}. Lastly, the study had a shorter follow-up period; therefore, it couldn't observe other possible complications such as clip slip or migration which has also been observed rarely²⁰.

CONCLUSION

Extra-corporeal and metallic endo-clip are two effective techniques for appendix base closure in laparoscopic appendectomy. Although usage of metallic endo-clip caused a shorter surgical time, it was found to be expensive and associated with more complications. However, it is anticipated that the higher rate of complications was not related to the technique but with confounding factors such as pre-operative conditions. Given the simplicity of the technique, we recommend using metallic endo-clips for base closure, but in poor economic setups, extra-corporeal knotting is suggested.

Author's Contribution:

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Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

- Stringer MD. Acute appendicitis. *J Paediatr Child Health* 2017;53(11):1071-6.
- Yilmaz S, Donmez T, Ferahman S, Akarsu C, Bulut S, Ozcevik H, et al. Partial cecum resection using endostapler in acute complicated appendicitis with appendiceal base necrosis. *Videosurg. Other Miniinvasive Tech* 2021;16(1).
- Lee SH, Lee JY, Choi YY, Lee JG. Laparoscopic appendectomy versus open appendectomy for suspected appendicitis during pregnancy: a systematic review and updated meta-analysis. *BMC Surg* 2019;19(1):1-12.
- Jaschinski T, Mosch CG, Eikermann M, Neugebauer EA, Sauerland S. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev* 2018(11): CD001546..
- Winter NN, Guest GD, Bozin M, Thomson BN, Mann GB, Tan SB, et al. Laparoscopic or open appendectomy for suspected appendicitis in pregnancy and evaluation of foetal outcome in Australia. *ANZ J Surg* 2017;87(5):334-8.
- Ciarrocchi A, Amicucci G. Laparoscopic versus open appendectomy in obese patients: A meta-analysis of prospective and retrospective studies. *J Minim Access Surg* 2014;10(1):4.
- Botchway E, Marcisz L, Schoeman H, Botchway PPK, Mabitsela EM, Tshifularo N. Laparoscopic versus open appendectomy: A retrospective cohort study on the management of acute appendicitis (simple and complicated) in children under 13 years of age. *Afr J Paediatr Surg* 2021;18(4):182.
- Sohn M, Hoffmann M, Pohlen U, Lauscher J, Zurbuchen U, Holmer C, et al. Stump closure in laparoscopic appendectomy. Influence of endoloop or linear stapler on patient outcome. *Der Chirurg; Zeitschrift für alle Gebiete der operativen Medizin* 2014;85(1):46-50.
- Fuentes EJ, Pérez EA, Díez R, Aguado P, Moreno C, Souto H, et al. Use of hem-o-lok clips for laparoscopic appendectomy in children: retrospective analysis and comparison to ligature loop and endoscopic surgical stapler. *Transl Gastroenterol Hepatol* 2021;6.
- Miyano G, Urao M, Lane GJ, Kato Y, Okazaki T, Yamataka A. A prospective analysis of endoloops and endostaples for closing the stump of the appendix in children. *J Laparoendosc Adv Surg Tech A* 2011;21(2):177-9.
- Di Saverio S, Mandrioli M, Sibilio A, Smerieri N, Lombardi R, Catena F, et al. A cost-effective technique for laparoscopic appendectomy: outcomes and costs of a case-control prospective single-operator study of 112 unselected consecutive cases of complicated acute appendicitis. *J Am Coll Surg* 2014;218(3):e51-e65.
- Escolino M, Becmeur F, Saxena A, Till H, Holcomb GW, Esposito C. Endoloop versus endostapler: what is the best option for appendiceal stump closure in children with complicated appendicitis? Results of a multicentric international survey. *Surg Endosc* 2018;32(8):3570-5.
- Cristalli BG, Izard V, Jacob D, Levardon M. Laparoscopic appendectomy using a clip applier. *Surg Endosc* 1991;5(4):176-8.

14. Gonenc M, Gemici E, Kalayci MU, Karabulut M, Turhan AN, Alis H. Intracorporeal knotting versus metal endoclip application for the closure of the appendiceal stump during laparoscopic appendectomy in uncomplicated appendicitis. *J Laparoendosc Adv Surg Tech A* 2012;22(3):231-5.
15. Erdoğan A, Türkan A. Comparison of Handmade Endoloop Versus Polymeric Endoclip for Stump Closure in Laparoscopic Appendectomy. *Cureus* 2021;13(7).
16. Arcovedo R, Barrera H, Reyes H. Securing the appendiceal stump with the Gea extracorporeal sliding knot during laparoscopic appendectomy is safe and economical. *Surg Endosc* 2007;21(10):1764-7.
17. Delibegović S, Mehmedovic Z. The influence of the different forms of appendix base closure on patient outcome in laparoscopic appendectomy: a randomized trial. *Surg Endosc* 2018;32(5):2295-9.
18. Ates M, Dirican A, Ince V, Ara C, Isik B, Yilmaz S. Comparison of intracorporeal knot-tying suture (polyglactin) and titanium endoclips in laparoscopic appendiceal stump closure: a prospective randomized study. *Surg Laparosc Endosc Percutan Tech* 2012;22(3):226-31.
19. Akbiyik F, Senel E, Bayram-Kabacam G, Demirkan H, Atayurt H, Tiryaki T. A comparison of polymer clips and endoloop applications for securing the appendiceal stump during laparoscopic surgery in children. *Surg Laparosc Endosc Percutan Tech* 2011;21(5):349-52.
20. Tsumura H, Ichikawa T, Kagawa T, Nishihara M, Yoshikawa K, Yamamoto G. Failure of endoscopic removal of common bile duct stones due to endoclip migration following laparoscopic cholecystectomy. *J Hepatobiliary Pancreat Surg* 2002;9(2):274-7.