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Endoclips Versus Intracorporeal Ligatures In Laparoscopic Appendectomy For Uncomplicated Appendicitis

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Abstract

Background: Acute appendicitis is a primary cause of acute abdominal pain & the most prevalent surgical emergency necessitating urgent intervention. Appendectomy is one of the most frequently carried out emergency techniques. This research aimed to compare endo-clips with intra-corporeal ligatures in the closure of the appendiceal stump through laparoscopic appendectomy.
Methods: Eighty-four cases identified with appendicitis were retrospectively recruited for randomized research from March 2023 to November 2024. The patients have been divided into two equal groups: Group A had laparoscopic appendectomy with endoclips for securing the appendiceal stump, whereas Group B utilized a ligature for the same purpose. The evaluation of both methods focused on safety, efficacy, operative time, and complications.

Results: Our study found no significant variances in demographic characteristics or preoperative comorbidities among the clip and ligature groups. Operative time was significantly shorter in the clips group (mean ± SD: 50.02 ± 10.71 minutes) compared to the ligature group (mean ± SD: 56.42 ± 9.51 minutes), with a p-value of 0.005. Complication rates were comparable among groups, with no significant differences in intraoperative bleeding from the mesoappendix (p = 0.645), bleeding from the port site (p = 0.557), or post-operative ileus (p = 0.645). Additionally, hospital stay didn't vary significantly among the groups (p = 0.649), indicating comparable postoperative recovery.
Conclusion: Ligation and clipping of the appendiceal base are both practical and safe, exhibiting similar complication rates. However, ligation requires more training and results in longer operative times, while clipping is simpler and easier for trainers.

Keywords: laparoscopic appendectomy, ligature, appendicitis, endoclips, appendiceal stump

Introduction

Acute appendicitis is a primary cause of acute pain of abdomen and the majority of prevalent surgical emergency necessitating urgent intervention, with a stated lifetime frequency of eight percent. Therefore, accurate and prompt identification of acute appendicitis is vital for reducing morbidity. Timely surgical intervention is crucial in reducing the risk of appendiceal perforation [1]. Notably, appendectomy, initially documented by McBurney in 1894, remains the typical treatment for appendicitis. There were few changes in surgical techniques for nearly a century, until Semm introduced the laparoscopic approach in 1983 [2]. Both laparoscopic and open methods are viable for performing an appendectomy. The laparoscopic approach is related to improved cosmetic outcomes, quicker recovery times, reduced morbidity, and shorter hospital stays. However, it may also lead to longer operating times, increased instances of intra-abdominal abscesses post-surgery and potentially higher costs for hospitals and patients. A crucial step in executing laparoscopic appendicectomy is the secure closure of the appendiceal stump, as insufficient closure may cause stump leakage, potentially resulting in intra-abdominal collections [3]. The current evidence on optimal techniques for mesoappendix ligation & stump closure during laparoscopic appendectomy still debatable. Stump closure can be attained with ligature methods or titanium clips, while mesoappendix division can be performed with simple electrocautery or mechanical devices. Furthermore, innovative vessel-sealing apparatuses, like ultrasonic systems, and electrothermal bipolar-activated LigaSure, like Harmonic, have gained widespread adoption in surgical practice and are becoming increasingly prominent. The implementation of these devices has been associated with reduced operative times across various surgical specialties [4]. Given the unique circumstances in our country, more cost-effective procedures, like intracorporeal suturing and handcrafted loops, are more appropriate. The adoption of titanium endoclips in surgical settings has simplified endoscopic procedures and significantly reduced operation times. These clips are easy to apply and don't need advanced surgical skills on the part of practitioners. Numerous studies have evaluated the effectiveness of metal clips for closing the appendix stump [5]. This study aimed to compare endo-clips with intra-corporeal ligatures. The primary focus was the closure of the appendiceal stump. The technique examined was a laparoscopic appendectomy. Complications were assessed as outcomes. Methods were evaluated for effectiveness.

Material and Methods

This research was retrospective comparative cohort research assessing the clinical results of 84 cases who had laparoscopic appendicectomy for acute appendicitis at the authors institute between March 2023 and November 2024. Patients were assigned to either endoclip closure of the appendiceal stump (Group A) or suture ligation (Group B). The study protocol received Institutional Review Board approval in line with the Declaration of Helsinki, & written informed consent has been attained from all participants. The laparoscopic grading system (LGS score) for acute appendicitis, proposed by Gomes et al. in 2012, classifies appendicitis based on visual findings during laparoscopy and was used for classification. Patients aged over twelve years diagnosed with uncomplicated acute appendicitis and presenting to the hospital within forty-eight hours of symptom onset have been involved in the research. Cases with appendiceal masses, perforation at the base of the appendix, generalized peritonitis, or appendiceal abscess formation were excluded from the study. All procedures have been conducted by laparoscopic surgeons with over 5 years of experience. A thorough history and clinical examination

have been conducted for all participants. For diagnostic confirmation, abdominal ultrasonography was routinely performed, and abdominal computed tomography with contrast was requested only when complications were suspected. Methods were evaluated for safety, efficacy, operative time, and complications.

Appendectomy technique

The surgical technique followed a standardized protocol. Prior to starting anesthesia, cases received a single dose of antibiotics (ceftriaxone 1 gm IV. and metronidazole 500 milligrams IV). The procedure has been conducted utilizing the conventional three-port approach. The patients have been positioned in the reverse-inclined Trendelenburg position. The pneumoperitoneum has been created using carbon dioxide (CO2). Intra-abdominal pressure remained within the range of 12-14 mmHg. Ports have been placed with a 10-millimeter port in the umbilicus, a 5-millimeter port in the left iliac fossa, & a 5-10mm port superior to the symphysis pubis. A camera fitted with 0° optics has been employed. Following visualization of the appendix, the mesoappendix has been dissected utilizing a harmonic scalpel. After preparing the appendiceal base, the handling of the appendix stump has been carried out as follows: (Fig. 1) In Group A, a titanium metal clip (LIGACLIP Extra Ligating Clip, Large, Ethicon Endo-Surgery, LLC, Cincinnati, OH) was applied to the base of the appendix. A 2nd clip has been positioned distally within the appendix, followed by its transection among the clips. Clips for the closure of the appendiceal stump weren't utilized in instances of significant inflammation at the base of the appendix. When the diameters exceeded the inner diameter of the closed clip (Fig. 2), in Group B, we employed Vicryl 2/0 ligature for the formation of intracorporeal knots. Specifically, two intracorporeal knots have been positioned at the base of the appendix, followed by a surgical incision made between these knots (Fig. 3).

Statistical analysis

The information collected has been analyzed utilizing the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, United States of America), version 26.0. The quantitative information has been expressed as mean ± SD & ranges when the distribution was parametric (normal). Qualitative parameters have been represented as numerical values and percentages. The Kolmogorov-Smirnov & Shapiro-Wilk tests have been utilized to evaluate the normality of the information. The subsequent tests have been performed. An independent-samples t-test has been utilized to evaluate the significance of the variance between the two means. The comparison of groups with qualitative information has been conducted applying the Chi-square test and Fisher's exact test, the latter serving as an alternative when the expected count in any cell under 5. The confidence interval has been established at 95% with an accepted margin of error of five percent. The p-value has been deemed significant as follows: P-value under 0.05 was categorized as significant, P-value under 0.001 as highly significant, and P-value above 0.05 as insignificant.

Results

In our study, there were insignificant variances in demographic data between the Clips Group and the Ligature Group. Age (mean ± SD: 39.33 ± 12.77 vs. 38.60 ± 14.33, p = 0.804), sex distribution (female: 83.3% vs. 76.2%, p = 0.415), and BMI (mean ± SD: 24.86 ± 3.04 versus 25.43 ± 4.76, p = 0.516) were comparable among groups, indicating that these baseline characteristics were well matched. Similarly, comorbidity data revealed insignificant variances between groups in rates of cardiac insufficiency (p-value equal 0.314), hypertension (p-value equal 0.557), or diabetes (p-value equal 0.557). Overall, these findings suggest that the Clips and Ligature Groups were balanced and comparable in demographic and comorbidity profiles at baseline (Table 1). Operative time, from pneumoperitoneum creation to port wound closure, was significantly shorter in the Clips Group (mean ± SD: 50.02 ± 10.71 minutes) than in the Ligature Group (mean ± SD: 56.42 ± 9.51 minutes, p = 0.005). Insignificant variances were found between groups regarding intraoperative bleeding from the mesoappendix (Clips: 7.1%, Ligature: 4.8%, p = 0.645), bleeding from the port site (Clips: 4.8%, Ligature: 2.4%, p = 0.557), or post-operative ileus (Clips: 4.8%, Ligature: 7.1%, p = 0.645). No cases of bowel injury or wound infection were observed in either group, indicating similar safety profiles. Hepatization were identical in both groups: Clips Group (mean ± SD: 1.05 ± 0.22 days) and Ligature Group (1.07 ± 0.26 days, p = 0.649), with both ranging from 1 to 2 days. Analysis of LGS Score distribution showed no significant differences in the

proportions of patients with Score 0-1 (Clips: 61.9%, Ligature: 45.2%, p = 0.127), Score 2 (Ligature: 38.1%, Clips: 23.8%, p = 0.159), or Score 3 (Ligature: 16.7%, Clips: 14.3%, p = 0.763), confirming comparable LGS outcomes. No intraoperative technical problems were encountered, and no cases required conversion to open surgery in either group (Table 2).

LGS Score by Gomes 2012: Score (0): Normal-looking appendix. Score (1): Hyperemia and edema (redness and swelling). Score (2): Fibrinous exudate (a layer of fibrin, a protein involved in blood clotting, on the appendix). Score (3): Segmental necrosis. Score (4): Abscess. Score (5): Diffuse peritonitis.

Table 1: Comparative analysis between the groups concerning preoperative data.

Baseline data	Clips Group (number=42)	Ligature Group (number =42)	Test value	p-value
Age/years				
Mean ± SD	39.33±12.77	38.60±14.33	0.249	0.804
Range	19-64	19-76		
Sex				
Female	35(83.3%)	32(76.2%)	0.664	0.415
Male	7(16.7%)	10(23.8%)		
BMI [wt/(ht)^2]				
Mean ± SD	24.86±3.04	25.43±4.76	-0.653	0.516
Range	20-30	3.1-30		
Cardiac insufficiency	0(0.0%)	1(2.4%)	1.012	0.314
Hypertension	1(2.4%)	2(4.8%)	0.346	0.557
Diabetes	2(4.8%)	1(2.4%)	0.346	0.557

Using: t-Independent Sample t-test for Mean ± SD; Using: $\chi 2$: Chi-square test for Number (%) or Fisher's exact test, when suitable. p-value above 0.05 is insignificant; *p-value under 0.05 is significant; **p-value under 0.001 is highly significant

Table 2: Comparison among the groups regarding intra- & postoperative data.

	Clips Group (n=42)	Ligature Group (n=42)	Test value	p-value
LGS Score 0-1	26(61.9%)	19(45.2%)	2.327	0.127
Score 2	10(23.8%)	16(38.1%)	1.985	0.159
Score 3	6(14.3%)	7(16.7%)	0.091	0.763
Score 4,5	0	0		
Intraoperative bleeding from the mesoappendix	3(7.1%)	2(4.8%)	0.213	0.645
Bleeding from the port site	2(4.8%)	1(2.4%)	0.346	0.557
Bowel injury	0(0.0%)	0(0.0%)		
Operation time "min." Mean±SD	50.02±10.71	56.42±9.51	2.896	0.005*
Postoperative ileus	2(4.8%)	3(7.1%)	0.213	0.645
Wound infection	0(0.0%)	0(0.0%)		
Hospital stay "days"	1.05±0.22	1.07±0.26	0.456	0.649

Fig. 1: A. Dissection of mesoappendix by Harmonic scalpel. (B). Separation of the mesoappendix from the appendiceal base

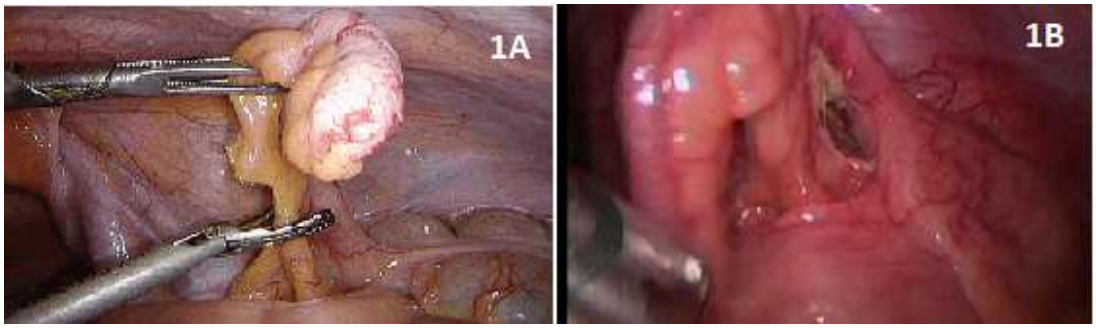


Fig. 2: A. Skeletonization of the appendix and application of proximal clip. B: cutting between the clips

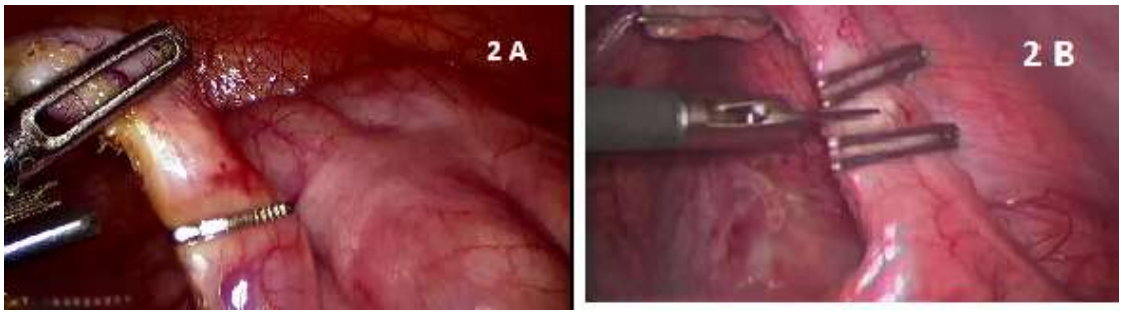
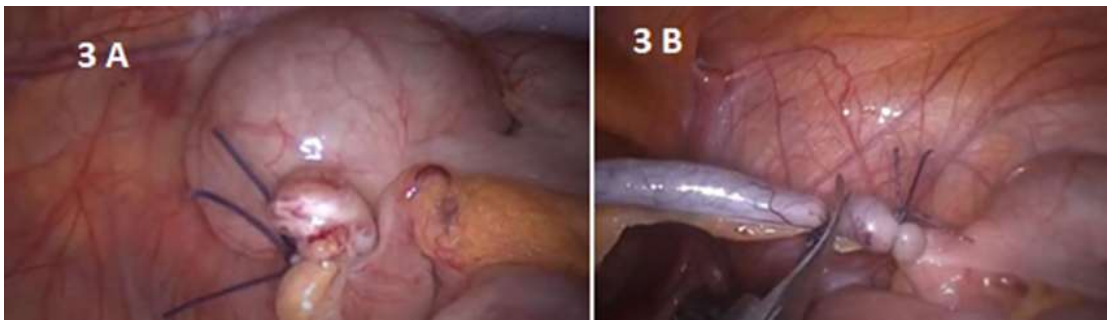


Fig. 3: A: Ligation of the appendiceal base. B: Cutting between the two ligatures.



Discussion

Appendectomy is one of the most frequently carried out emergency procedures. For numerous years, open appendectomy has been considered the gold standard treatment. However, laparoscopic techniques now offer a better alternative. These techniques provide better cosmetic results, shorter hospital stays, and improved postoperative outcomes. Additionally, laparoscopic procedures can effectively diagnose suspected cases of appendicitis [6]. A critical step in this operation is closing the appendiceal stump, which can be done using various techniques, including knots, clips, and staplers. However, the choice of device for closing the appendiceal stump is often debated throughout the procedure due to concerns about potential leaks. These leaks can lead to infections and other postoperative complications [7]. In this study, patients admitted to our hospital were compared using the intracorporeal knot & endo-clip methods for securing the appendiceal stump. LA is a safe method for dealing with uncomplicated acute appendicitis. Nevertheless, there is no widespread agreement regarding the laparoscopic management of complicated appendicitis, as investigations indicate varying rates of post-operative intra-abdominal abscess (POIAA). Consequently, the perioperative categorization of uncomplicated and complicated acute appendicitis is highly valuable [8]. In the present study, we used the laparoscopic grading system for acute appendicitis, proposed by Gomes et al. in 2012. [9]. Complication rates after surgery are

greater in cases with complicated appendicitis, in spite of the method applied for appendix stump closure, and involve wound infection, intra-abdominal abscess formation, and paralytic ileus. This recommends that the primary factor influencing complications following the operation is the severity of the illness itself, rather than the technique used for stump closure in cases of complicated appendicitis [2]. In the early stages of laparoscopic surgery, endoloop ligatures were used effectively to obliterate the stump. However, their application is subject to several limitations, including the risk of ligature slippage and the resulting increase in associated costs [3]. Due to the limited availability of Endoloop in our hospital and its associated high costs, we have chosen to implement intracorporeal knot-tying techniques. This method requires greater expertise than alternative approaches and has a steeper learning curve. Nonabsorbable titanium endoclips are commonly utilized in surgery. Researchers, particularly in laparoscopic cholecystectomy, have illustrated that titanium endoclips are safe and effective. Numerous procedures now use titanium endoclips, which simplify endoscopic procedures and reduce operating times. It is easy to use and does not require significant surgical expertise [10]. The application of metal clips to close the appendiceal stump has been first portrayed by Cristalli et al. The surgeon's expertise, the hospital's availability of equipment, expenses, and the degree of appendix inflammation will all influence the ultimate choice of the stump closure technique [11]. In our study, we observed insignificant variances in intraoperative or postoperative complications between laparoscopic clipping & intracorporeal suturing for the closure of the base of the appendix. Both methods demonstrated comparable safety, cost-effectiveness, and reliability. The selection between these methods is influenced by factors such as surgeon expertise, equipment availability, the diameter of the appendix base, and the degree of inflammation present. Nevertheless, there are serious concerns about the adequacy of clips, particularly when the appendix is notably enlarged, as they may not provide sufficient security.

Hem-o-lok is a V-shaped clip crafted from a nonabsorbable polymeric material and is available in numerous sizes. It has become commonly utilized in cardiovascular and urologic procedures for ureteral and vascular ligation [12]. The initial application of hem-o-lok for the laparoscopic closure of the appendix stump has been stated by Hanssen et al [13]. In their study involving 14 patients, the appendiceal stumps were ligated using polymeric clips, and importantly, no complications associated with the clips were noted during follow-up assessments conducted between 3 weeks and 6 months post-procedure. Sahm & his colleagues validated in their research that intra-corporeal ligation is a safe substitute to the more expensive linear stapler and the less expensive endoloop, demonstrating insignificant variance in effectiveness and safety [14]. Kiudelis & colleagues stated that intra-corporeal ligation is a safe & more cost-effective method compared to the endoloop technique [15]. Rickert and colleagues employed a titanium double-shanked clip in their research, demonstrating its capability to securely fasten appendiceal bases up to 2 cm safely [16]. This study differed from ours, as we used a standard medium- to large-sized clip, which is inadequate for securing a 2 cm diameter. Additionally, a significant limitation noted by Rickert & colleagues was the requirement for a 12 mm port to introduce the clip applier. The use of clips is not considered a significant limitation, as most surgeons require this port for appendix retrieval [17]. Makaram et al. found that endoclips represent the most time-efficient closure method; however, this conclusion didn’t reach statistical significance. Additionally, although endoscopic suturing demonstrates considerable safety and efficacy for stump closure, its related costs limit its application primarily to the most severe cases of appendicitis [18]. Our study aligns with previous research indicating that the application of metallic clips for appendiceal stump closure is safe & correlates with reduced operative time in laparoscopic appendectomy. The technique is simplified and offers a viable alternative to intra-corporeal ligation. Using clips has the benefit of allowing one to apply them precisely to the required location. The main drawback of the clip is its difficulty in applying to a thick or appendiceal base with acute and friable inflammation. The advantages of the clip technique include its ease of application, reduced operative time, and negligible cost [19]. Our study has shown that endoclips are effective for appendiceal stump closure and have a safety profile comparable to intracorporeal suturing. There were insignificant variances in perioperative outcomes or length of hospital stay among both groups. Although current evidence suggests that endoclips may be a reliable option, further multicenter, prospective investigations with proper randomization and design are necessary. These studies should encompass all grades of appendicitis to provide a comprehensive evaluation. Only after such rigorous investigation can the medical community confidently recommend endoclips as a standard practice for securing the base of the appendix in laparoscopic appendectomy.

Conclusion

Both intracorporeal sutures & endoclips have demonstrated safety and efficacy in closing the appendix stump throughout laparoscopic appendectomy. While intracorporeal knotting requires more time, it yields satisfactory outcomes. Endoclips, on the other hand, offer a straightforward, effective, and cost-efficient alternative.

Declarations

Data Availability Statement: The information that support the results of this research are accessible on request from the corresponding author.
Ethics Committee Approval: Ethical committee approval has been received from the Institutional Review Board of Al-Azhar University (Registration no: 2900/2025).
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