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Original Article

Comparison between Laparoscopic Suturing and Metallic Endoclips in the Closure of Appendiceal Stumps during the Laparoscopic Management of Complicated Appendicitis

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ABSTRACT

Background: Closure of the appendiceal stump is a crucial step during laparoscopic appendectomy. Multiple techniques have been described to close the appendiceal stump, with no clear consensus on which one offers the best results. In addition, most comparative results included patients with uncomplicated appendicitis. In this study, the intracorporeal sutures and metallic endoclips were compared in appendiceal stump closure in cases with complicated appendicitis.
Methodology: One hundred patients were enrolled in this prospective randomized trial and divided into two groups: The endoclip group (n = 50) and the Suture group (n = 50). Postoperative outcomes were compared between the two groups.
Results: Both preoperative and intraoperative findings were statistically comparable between the two approaches. Nonetheless, the application of metallic clips was associated with a significant shortening in the operative time (75 vs. 95 minutes with sutures). All patients were discharged within 24 hours after the operation. Only one patient (2%) required readmission in the suturing group. That patient presented with ileus, and radiological assessment revealed the presence of a postoperative intraabdominal abscess that needed reoperation via laparoscopy (for evacuation and drainage) that was the only patient who required readmission and reoperation in the current study. No patients developed fecal fistula, whereas port site infection occurred in 8% of cases in each group.
Conclusion: Both metallic endoclips and intracorporeal sutures are available safe options for appendiceal stump closure during laparoscopic appendectomy for patients with complicated appendicitis. However, the former could provide a benefit over the latter, manifested in the decreased operative time.

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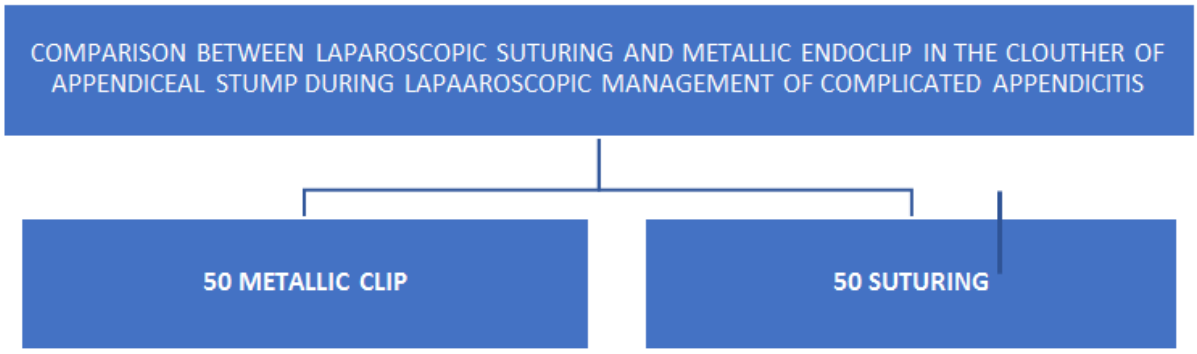
GRAPHICALABSTRACT



Introduction

Acute appendicitis is the most common surgical abdominal emergency that is frequently encountered in daily emergency surgical practice [1]. It is commonly encountered in individuals aged between 5 and 45 years, with an incidence of 233 per 100,000 individuals [2]. The lifetime risk for getting that entity ranges between 6.7% and 8.6% [3, 4]. Despite the common prevalence of acute appendicitis, its diagnosis could be missed in up to 23% of adults and 15% of children on their first visit to the emergency department [5, 6]. The delay in the diagnosis and improper management of these cases could lead to appendiceal gangrene, perforation, abscess formation, and secondary peritonitis [7, 8]. Complicated appendicitis is not uncommon, as it could be detected in 4-25% of appendicitis patients during their initial hospital admission [9]. According to the "World Society of Emergency Surgery," non-operative treatment with antibiotics and percutaneous abscess drainage could be a feasible option for complicated appendicitis. Nonetheless, laparoscopic intervention provides more superiority compared to the conservative approach regarding hospitalization period, readmission rate, and the need for additional interventions, especially if performed by experienced surgeons [10]. Securing the appendiceal stump is a critical step during the appendectomy procedure. It should be properly closed to decrease the risk of postoperative abscess formation, peritonitis, and sepsis [11]. That could form some problems for surgeons working on complicated cases due to the presence of adhesions, unclear anatomy, and edematous friable tissues [12]. Different closure techniques have been described for securing the appendiceal stump during laparoscopic appendectomy, including intracorporeal sutures, extracorporeal sutures, metallic clips, polymeric clips, endoloops, and endostaplers [13, 14]. Suturing and metallic clips are the two most common techniques used in our tertiary care Egyptian setting to close the appendiceal stump. Other methods like polymeric clips and staplers are not preferred, especially in a poor country living on external aid, like Egypt.

Although suturing and metallic clips have been compared in patients undergoing laparoscopic appendectomy [15-18], the majority of the included cases in these studies had uncomplicated disease. That was a good motive for us to conduct the current study, which was performed to compare the perioperative outcomes of intracorporeal sutures versus metallic endoclips for appendiceal stump closure in patients with complicated appendicitis.

Materials and Methods

The current prospective randomized trial was conducted at Al-Azhar University General Surgery Department between July 2021 and July 2023 (two-year duration).

Patient enrollment and data collection started after gaining approval from the scientific committee of Al-Azhar University. Our trial was designed for patients diagnosed with complicated appendicitis, whatever their age. The diagnosis of complicated disease was established when any of the following findings were detected (on preoperative imaging and confirmed by intraoperative findings): phlegmon formation, peri appendiceal abscess, appendiceal perforation, or gangrenous appendix [19]. On arrival at the emergency surgery department, all patients were adequately assessed, and that assessment included history taking (focusing on age, gender, comorbidities, and compliant with its duration), clinical examination (focusing on patient look, body mass index, vital sign assessment, and local abdominal examination), and laboratory investigations (focusing on leucocytic count, C-reactive protein, and coagulation profile). Radiological assessment was done via abdominopelvic ultrasonography, which was ordered for all cases by an experienced radiologist. In addition, computed tomography with IV contrast was ordered for some patients with doubtful diagnoses. After proper patient assessment, we excluded patients with any of the following criteria: previous abdominal surgery, uncomplicated appendicitis (catarrhal or suppurative appendicitis not meeting the previously mentioned criteria of complicated disease), caecal masses (including neoplasms), septic shock on presentation, pregnancy, coagulation disorders, or any contraindication to general anesthesia or laparoscopic intervention. One hundred patients met our inclusion criteria, and they were assigned into two groups using computer-generated randomization; the first group (n = 50) included patients who had their stump closed by metallic clips, and the second group (n = 50) included the other patients whose stump was closed by intracorporeal sutures. All patients were informed about the aim of the trial, the advantages, and potential complications of the surgical intervention. Their approval was documented by a written consent that was signed by the patients themselves (or their guardians if their age was less than 18 years). The appendectomy procedures were performed under general anesthesia when the patient was in the Trendelenburg position with a slight left tilt. Abdominal insufflation was done via the Veress needle, followed by the insertion of the camera 10-mm port in the midline just above the umbilicus. The two working ports were inserted at the same level in the right and left midclavicular lines (one 10-mm and another 5-mm port). The operator was standing beside the patient's head with the cameraman on the left side. A broad-spectrum antibiotic (ceftriaxone 2 gm) was commenced at the time of the skin incision, along with IV metronidazole (500 mg). The dosage of both antibiotics was adjusted according to body weight in children. The abdominal cavity was explored, and any purulent free fluid was aspirated (Figure 1a). The phlegmon was carefully dissected with careful identification of the underlying organs. Any underlying abscess cavity was opened, and the discharging pus was aspirated (Figure 1b). Dissection was continued till the freeing of the omentum and identification of the underlying appendix and caecum. The tail of the appendix was carefully dissected from the surroundings till complete freeing of the mesoappendix. We then started a division of the mesoappendix using electrocautery, and the appendicular artery was carefully cauterized or controlled by a metallic clip. The appendix dissection was continued until we reached a healthy area at the appendiceal base. According to the group allocation, the appendiceal stump was secured. In the first group, the stump was secured by two metallic clips (Figure 1e), while in the other group, it was controlled by two transfixing vicryl 2/0 sutures (Figure 1d). After securing the appendiceal stump, the appendix was divided by scissors just distal to the suture or the clip, and then it was delivered outside the abdomen through the 10-mm working port. After that, the abdomen was properly washed with warm saline, and care was taken to not just involve the bed of the appendix, but we also washed the pelvis, the perihepatic, and the perispelnic recesses. A surgical drain was inserted into the pelvis through the working 5-mm port to drain any residual fluid. The remaining ports were closed by non-absorbable sutures after abdominal desufflation. In the

surgical ward, early ambulation was encouraged, and oral fluid intake was allowed six hours after the operation. All patients were discharged within the same operative day (within 24 hours after the operation).

They were commenced on an oral broad-spectrum antibiotic in addition to metronidazole for five days after the operation. In addition, analgesia was maintained by oral paracetamol (every 8 hours) and diclofenac potassium (when required). Follow-up visits were arranged on a weekly basis. The patients were asked to present to the surgical emergency department if they developed any signs of complications (intolerable abdominal pain, persistent vomiting, persistent fever, abdominal distension, etc.). The incidence of complications, including wound infection, dehiscence, ileus, and intraabdominal abscess formation, was recorded in both groups and taken as our primary outcome. Furthermore, the need for readmission and reoperation was recorded. These were taken with the operative time and the hospitalization period as our secondary objectives.

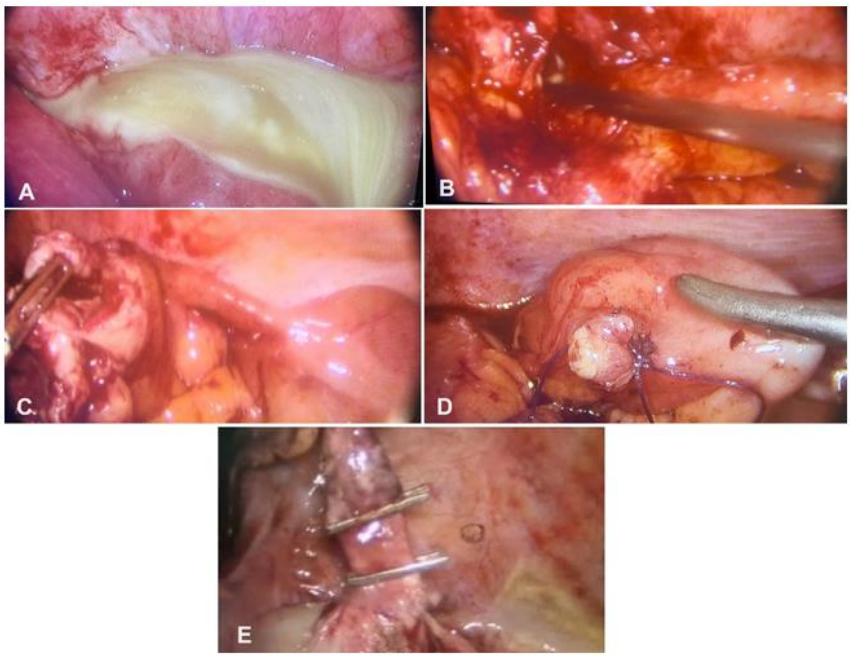


Figure 1: (A) Free purulent fluid in the abdominal cavity around the appendix, (B) a pelvic abscess related to the tip of the appendix during aspiration, (C) gross perforation of the appendix, (D) after closure of the stump by transfixing sutures, and (E) after stump closure by metallic clips

Table 1: Baseline demographic data

	Metallic clip group (n = 50)	Suturing group (n = 50)	P-value
Age (years)	34 (9 – 60)	37 (8 – 59)	0.772
Age category -< 18 years -> 18 years	 12 (24%) 38 (76%)	 13 (26%) 37 (74%)	0.304
Gender -Male -Female	 27 (54%) 23 (46%)	 31 (62%) 19 (38%)	0.418
Comorbidities -Type II diabetes -Hypertension -Ischemic heart disease	 5 (10%) 5 (10%) 1 (2%)	 6 (12%) 5 (10%) 1 (2%)	 0.749 1 1
Smoking	7 (14%)	5 (10%)	0.538

Sample size calculation

IBM Sample Power software was used to calculate the proper sample size. According to the previous study published by Ates and his associates, postoperative complications occurred in 3.2% of the metallic clip group, compared to 10% in the suture group (difference = 6.2%) [16]. Fifty patients were required in each of our groups to detect a 10% difference in postoperative complication rate at a 0.05 significance level and 80% study power.

Statistical analysis

IBM SPSS software was used for tabulation and analysis of the previously collected data. The chi-square test was used to compare categorical variables that were presented as numbers and percentages. Regarding numerical data, the Mann-Whitney test was used to compare skewed data (medians and ranges), whereas the student-t test was applied to compare non-skewed data (means and standard deviations). Any p-value measured less than 0.05 was considered significant.

Results and discussion

As indicated in Table 1, age distribution was statistically comparable between the two groups, as adults represented 76% of the metallic clip group and 74% of the suturing group. The remaining patients were children. Gender distribution did also differ between the two groups, with a higher male predominance in both groups compared to females. In addition, the prevalence of different medical comorbidities and smoking did not differ between the same groups.

Data regarding history taking, clinical examination, and relevant laboratory investigations are presented in Table 2. Abdominal pain was reported by all patients. Other complaints included nausea, vomiting, anorexia, and diarrhea. Regarding the examination findings, right lower quadrant tenderness was evident in all patients, while generalized abdominal tenderness was noted in 38% of metallic clip cases and 44% of suturing cases. Other findings included abdominal guarding, palpable mass, and fever. The leucocytic count had a median value of 17.15 x 109/L in the metallic clip group and 17.9 x 109/L in the suturing group. Moreover, CRP had median values of 125 and 126 gm/dl in the same groups, respectively. All of the previous parameters expressed no significant differences between the two groups.

Gross operative findings did not show differences between the two groups. All patients showed phlegmon and evidence of appendiceal perforation during the procedure. Other findings included periappendiceal abscess, gangrene of the appendix, and intraabdominal free purulent fluid. One should know that all patients with generalized abdominal tenderness had intraoperative free pus in the abdominal cavity. The application of metallic clips led to a significant decline in operative time, which had a median value of 75 minutes compared to 95 minutes in the suturing group. There was no need for conversion to the open approach in the current study. Table 3 illustrates the previous data.

The hospitalization duration ranged between 12 and 22 hours in both study groups. The incidence of postoperative complications did not significantly differ between the two groups (p = 0.727). Only one patient developed postoperative intraabdominal abscess, and that case was a child in the suturing group. That patient presented with ileus and abdominal pain and required readmission. Surprisingly, on laparoscopic re-exploration, the appendiceal stump was healthy, suggesting that collection was due to missed collection from the initial procedure. That abscess cavity was drained with a good abdominal toilet. That patient was the only one who needed readmission and reoperation in the current study. Other complications included port site infection that occurred in 8% of cases in both groups, and all of these adverse events occurred in the 10-mm working port through which the appendix was extracted. All patients required only frequent dressing with local and systemic antibiotics. Table 4 summarizes the previous data.

Table 2: History taking, clinical findings, and preoperative inflammatory markers

	Metallic clip group (n = 50)	Suturing group (n = 50)	P-value
History taking			
-Abdominal pain	50 (100%)	50 (100%)	-
-Nausea and vomiting	41 (82%)	39 (78%)	0.617
-Anorexia	34 (68%)	37 (74%)	0.509
-Diarrhea	4 (8%)	2 (4%)	0.400
Clinical examination			
-Right lower abdominal tenderness	50 (100%)	50 (100%)	-
-Generalized tenderness	19 (38%)	22 (44%)	0.542
-Guarding	27 (54%)	25 (50%)	0.689
-Fever	42 (84%)	44 (88%)	0.564
-Palpable mass	19 (38%)	21 (42%)	0.683
Total leucocytic count (109/L)	17.15 (10.4 – 25)	17.9 (10 – 25)	0.336
CRP (mg/dl)	125 (71 – 178)	126 (70 – 179)	0.777

Table 3: Operative findings

	Metallic clip group (n = 50)	Suturing group (n = 50)	*P*-value
Gross operative findings			
-Phlegmon	50 (100%)	50 (100%)	-
-Abscess	31 (62%)	28 (56%)	0.542
-Perforation	50 (100%)	50 (100%)	-
-Gangrene	16 (32%)	18 (36%)	0.673
-Free abdominal purulent fluid	19 (38%)	22 (44%)	0.542
Operative time (minutes)	75 (60 – 90)	95 (70 – 120)	< 0.001 **
Conversion to the open approach	0 (0%)	0 (0%)	-

Table 4: Hospitalization period and the duration of hospitalization

	Metallic clip group (n = 50)	Suturing group (n = 50)	P-value
Hospitalization period (hours)	16 (12 – 22)	17 (12 – 22)	0.790
Ileus	0 (0%)	1 (2%)	0.315
Intraabdominal abscess	0 (0%)	1 (2%)	0.315
Fecal fistula	0 (0%)	0 (0%)	-
Port site infection	4 (8%)	4 (8%)	1
Readmission	0 (0%)	1 (2%)	0.315
Reoperation	0 (0%)	1 (2%)	0.315
Overall complications	4 (8%)	5 (10%)	0.727

To the best of our knowledge, our trial is the first prospective randomized one to handle a comparison between two stump closure techniques in patients with complicated appendicitis. That is a great advantage in favor of our research. The other advantage is the lack of significant differences between our two groups regarding preoperative data, and that should decline the possibility of any bias skewing our findings in favor of one approach over the other. In our study, the use of metallic clips was associated with a significant shortening in the operative time. That is a reasonable consequence, as the application of clips during the operation is expected to take less time compared to the performance of two transfixing sutures. Our findings were confirmed by other authors who compared the same two techniques in patients with uncomplicated appendicitis. Gonenc *et al.* reported that the operative time ranged between 20 and 100 minutes in the metallic clip group (mean = 46.3 ± 19.8), while that time ranged between 30 and 135 minutes in the suturing group (mean = 61.9 ± 27.1) [15]. Ates and his

associates reported that the mean operative time was 41.27 ± 12.2 minutes in the metallic clip group, which increased significantly to 62.81 ± 15.4 minutes in the suturing group (p = 0.001) [16]. We did not encounter any cases that needed conversion to the open approach in our study. That coincides with the reported range for conversion during laparoscopic appendectomy mentioned in the literature (0-47%) [20-23]. All patients were discharged from the hospital within 24 hours after the procedure in our study, and we discharged them after ensuring adequate fluid intake without vomiting. We believe in the ambulatory surgery concept when dealing with acute appendicitis cases, including complicated ones. That is based on the study conducted by Gignoux *et al.*, who reported that ambulatory surgery is a safe option for both complicated and non-complicated appendicitis. These authors even reported a lower complication rate in the ambulatory surgery group compared to the conventional one (11.9% vs. 25%, respectively, p = 0.029) [24]. That should be of great benefit in a low-income country like Egypt, as this approach will cost less healthcare expenditure. On the other hand, other authors reported a longer hospitalization period for complicated appendicitis performed by laparoscopy. Mohamed and Mahran reported a hospitalization period of 5.3 ± 2.1 days for patients with the same criteria [25]. In addition, Güler *et al.* reported that the hospitalization period after laparoscopic appendectomy for complicated appendicitis ranged between one and 22 days (median = 3 days) [26]. One should expect some differences among studies regarding that parameter according to patient criteria, perioperative complications, and surgical center protocol. In the current study, we noted no significant difference in postoperative complication rates between the two groups. That was also reported by Ates *et al.*, who reported complication rates of 10% and 3.22% in the suturing and slip groups, respectively, which was also comparable in the statistical analysis (p = 0.939) [16]. Our findings showed no significant difference between the two closure methods in the incidence of postoperative intraabdominal abscess, which was only encountered in one patient (2%) in the suturing group, and it was secondary to a remnant collection not due to stump leakage, as the appendiceal stump was healthy in the second laparoscopic assessment. This is even lower than the reported range for the same adverse event in the literature, which ranges between 3% and 25% [27]. Other authors reported an incidence of 12.3% for the same complication after laparoscopic appendectomy for complicated appendicitis [28]. We did not encounter any patients with postoperative fecal fistula in the current study. Although fecal fistula is commonly associated with appendectomies for complicated appendicitis, its frequency is still low (0.5%), as reported in the literature [29, 30], which confirms our findings. Our study revealed the incidence of port site infection in 8% of patients in both study groups. Although laparoscopy is associated with less risk of surgical site infection compared to the open approach, a 2019 meta-analysis reported that wound complications could occur after laparoscopic management of complicated appendicitis with a range of 12.3% [31]. Another study reported an incidence rate of 9% for the same complication after appendectomy [32]. We did not notice significant differences between the two stump closure approaches regarding readmission or reoperation rates. Gonenc *et al.* reported similar outcomes as readmission rates were 4.9% and 8.7% in the clips and suturing groups, respectively, while reoperation rates were 0% and 2.1% in the same groups, respectively [15].

In addition, Ates *et al.* reported that the reoperation rate was 3.22% in the clip group and 0% in the clip group [16]. Our trial handled a unique surgical perspective. However, it has some drawbacks. The relatively small sample size that was collected from a single surgical institution is the main one. That should encourage surgeons to conduct more studies to handle the previous drawbacks.

Conclusion

Both metallic endoclips and intracorporeal sutures are available safe options for appendiceal stump closure during laparoscopic

appendectomy for patients with complicated appendicitis. However, the former could provide a benefit over the latter, manifested in the decreased operative time.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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