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Evaluation of Handmade Extra-Corporeal Loop versus Metallic Clips in Securing the Appendicular Stump in Laparoscopic Appendicectomy

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Abstract

Introduction: Laparoscopic appendicectomy has gained popularity due to the advantages of minimal-access surgery. Inadequate closure of the appendix stump leads to intra-abdominal surgical site infection or even fecal fistula. The base of the appendix can be secured with endostapler, endoloops, metallic clips or intracorporeal ligature. ***Aim***: To evaluate the handmade extra-corporeal loop versus endoclip in securing the base of the appendix in non-complicated acute appendicitis. ***Methods***: During the period from April 2014 to February 2016, in South Valley University, Aswan University and Sohag University hospitals (these are tertiary hospitals), 400 laparoscopic appendicectomy patients were included in this prospective study. In total, 240 patients were female and the overall average age was 25.6 years old. Patients were divided into two equal groups (group L and group C): in group L, handmade extra-corporeal loop was used to secure the base of the appendix, the metallic clip was used in group C. ***Results***: The mean operative time was 49 min in group L and 35.4 min in group C ($P < 0.05$). The mean hospital stay was 2.07 days in group L and 2 days in group C, and this was not significant ($P > 0.05$). Complications varied between port-site wound infection and delayed intestinal sounds, fecal fistula and there were no statistically significant differences. ***Conclusion***: Using extracorporeal handmade loop or the metallic clips to secure the appendicular stump is safe, feasible, easy and inexpensive methods. The loop takes a little more time in its preparation. Metallic clips are inappropriate for edematous wide base appendix.

Subject Areas

Surgery & Surgical Specialties

Keywords

Clipping of Appendicular Stump, Endoloops, Handmade Loop

1. Introduction

Since the laparoscopic appendectomy was first described in 1983 by Semm [1], it has become a frequently used alternative in the treatment of acute appendicitis. Various methods are used to secure the appendicular stump during laparoscopic appendicectomy for acute appendicitis. Each technique has its own potential advantages and disadvantages. Endo-GIA staplers are expensive instruments. Titanium clips may be slipped from their primary position. A Hem-O-Lock clip is a non-absorbable polymer clip with a lock-engagement feature and teeth within the jaws, which may provide greater security [2]. Base control was further tried by polymeric clips [3] [4], PDS endoloops [5], ligature by polyglactin suture [6], and endorings [7]. Stapling technique results in the safest closure of the stump, but it is also the most expensive method [8]. In addition, endoloop application requires some techniques and a short training period [9]. In this study, the evaluation of securing the base of the appendix with extracorporeal handmade loop versus metallic clips was performed regarding their safety and cost, and any expected specific complications.

2. Objectives

The primary objective of this study was to evaluate both techniques regarding their safety and to report any complication specific to each technique. Difficulty or insecure knotting or clipping of the appendicular stump due to any cause was reported as failure of the technique.

3. Patients and Methods

During the period from April 2014 to February 2016, in South Valley, Aswan and Sohag University Hospitals, 400 patients presented to emergency department with non-complicated acute appendicitis were included in this prospective study. Patients that refuse surgery and prefer medical treatment, Patients that ask for open appendectomy and patients with complicated appendicitis (Perforated appendix, appendicular abscess, and appendicular mass) either diagnosed pre-operatively or during laparoscopy were excluded from the study. This study is accepted by our local ethical committee and a written informed consent will be obtained from each participant.

In total, 240 patients were female and 160 were male. Patients were divided into two equal groups (group L and group C); the first case was selected randomly, then in a sequential manner. In Group L, The appendicular stump was secured with extracorporeal handmade loop. In group C, The appendicular stump was secured with titanium clips.

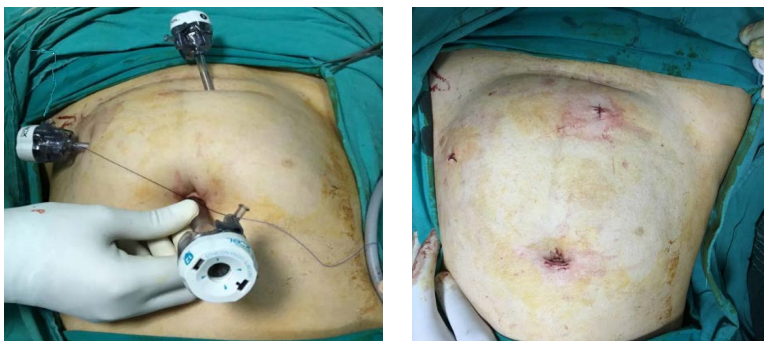
All patients were subjected to full history taking, clinical evaluation, abdominal ultrasound, and routine laboratory investigations. Informed consent was taken and pa-

tients with any criteria that interfere with laparoscopic surgery were excluded from the study, for example; pregnancy, previous lower abdominal surgery and hostile abdomen, age less than 15 years or more than 60 years, and concomitant morbidities that interfere with laparoscopic surgery, for example, patients with ASA III physical status.

Before surgery, all the patients received standard intravenous antibiotics (1.2 g of amoxicillin and clavulanic acid and 500 mg of metronidazole). Discharge criteria were audible intestinal sounds and tolerance of oral fluid intake. Postoperative analgesia and antibiotic was continued for 5 - 7 days. Stitches were removed in the 7^{th}-10^{th} post-operative day. Patients were followed up for 6 months to report any early or late postoperative complications.

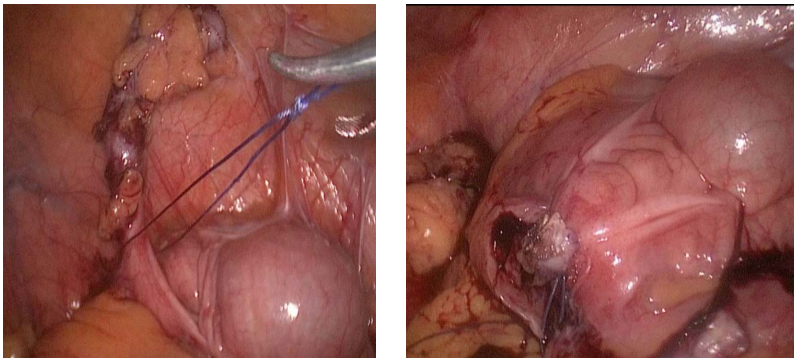
3.1. Surgical Procedure

The surgeon stood to the left side of the patient. Then, three ports were used**:** the first one was 12 mm port (Optical trocar) located in the periumbilical region to introduce a 0˚ - 30˚ Karl Storz optic telescope, two more working ports; 5 mm port was inserted suprapubically, and a 10 or 5 mm port was placed in the left lower quadrant of the abdomen (**Figure 1**); this port can also be used for the telescope, using the periumbilical port as a working port for the right hand and the right one as a working port for the left hand (this was an alternative option for standard port uses).The patient was then positioned in the Trendelenburg with a mild-left tilt, to facilitate the exposure of the appendix. Dissection of the appendix and control of the appendicular artery by Harmonic scalpel was performed. The appendicular stump closure was secured by applying a Hand Made Loop (HML) by polyglactin suture size 0 in group L (**Figure 2(a)** & **Figure 2(b)**). In group C, the stump was secured by two or three large titanium endoclips on the healthy firm tissue next to the caecum (**Figure 3(a)** & **Figure 3(b)**). A distal clip (spaced 10 mm from the proximal one) was applied to permit a cut in between. It was noticed that the appendix base becomes wider in its attachment to the caecum, and the clip cannot secure 100% of the stump diameter and so it was better to clip 0.75 cm away from the caecum to achieve proper occlusion. After sectioning of the appendix, the abdominal cavity was reassessed for any local or remote fluid collection or bleeding. A tubal drain may be placed according to the volition of the surgeon. Diagnosis of opera-



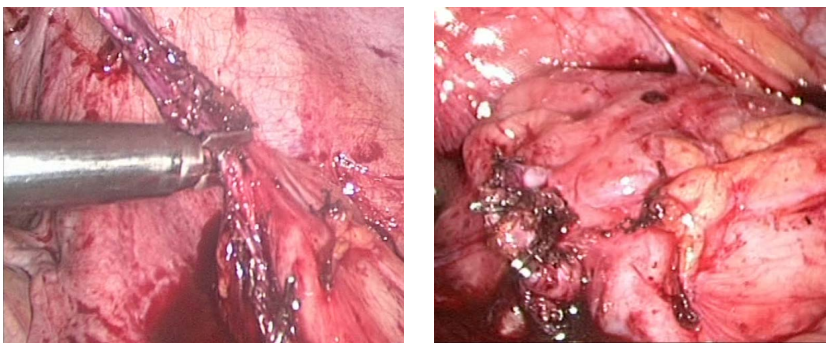
(a) (b)

Figure 1. The sites of Trocars (a) & (b).



(a) (b)

Figure 2. The appendicular stump closure was secured by applying a Hand Made Loop.



(a) (b)

Figure 3. The appendicular stump closure was secured by applying large titanium endoclips.

tive and post-operative complications were defined and reported as bleeding, iatrogenic injury, endoclip escape, small-bowel obstruction, or enteric leak.

3.2. Statistical Analysis

SPSS, 22.0 for windows (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. Categorical qualitative variables were expressed as absolute frequencies (n) and relative frequencies (%). p values < 0.05 were considered statistically significant.

4. Results

The mean age was 25.4 years old in group L and 25.8 years old in group C. The mean operative time was 49 min in group L and 35.4 min in group C ($P < 0.05$). The mean hospital stay was 2.07 days in group L and 2 days in group C ($P > 0.05$). The HML technique was successful to close the appendix base safely in 98% of the patients in group L and in 90% of the patients in group C ($P < 0.05$). 4 of patients with failed by clipping, completed successfully by the loop.

There were no statistically significant differences detected between the two groups in terms of the distribution of age, sex and the appendix location ($P > 0.05$).

There were no intraoperative complications such as bleeding or intestinal injury. No statistically significant differences were detected between the groups in terms of the

hospital stay, the follow-up time, and operative or postoperative complications ($P > 0.05$).

Postoperative complications in group L were as follows: two (1%) patients had port-site skin infection; one (0.5%) patient showed delayed intestinal sounds for 72 h and improved by medications.

In group C, one (0.5%) patient had port-site skin infection and 2 patient was readmitted after 3 days due to fever (38.5˚) and lower abdominal pain and tenderness; the patient was admitted for 48 h; there was mild leukocytosis, and an abdomino-pelvic ultrasound denoted no collection, and so blow out and leak were excluded; antibiotic and antipyretic were given to this patient with rapid improvement and discharge. 2 patients has low output fecal fistula, about 100 ml per day which decreased gradually till eventually stopped spontaneously within 7th and 10th days.

The conversion to open technique was needed in 4 (2%) patients in group L due to cutting through the appendix by the loop, and in 16 (8%) patients in group C due to incomplete stump closure, or cutting through the base($P < 0.05$).

Cases with complicated appendicitis (perforated, gangrenous, friable, abscess), were excluded from this study to avoid mis-attribution of specific complication to the procedure rather than the pathology of the appendix. The outcomes are shown in **Table 1** and complications in **Table 2**.

5. Discussion

Appendicitis is the most common cause of acute abdomen. Appendectomy is associated with significant morbidity.

Laparoscopic appendectomy in comparison with open appendectomy is associated with decreased pain, earlier resumption of diet, and decreased length of hospital stay for laparoscopic appendectomy. Especially young female, obese, and employed patients seem to benefit from LA [10].

The most important factor in deciding which technique to use in the clinical routine is the cost-benefit analysis. The economics of public health intervenes in the daily routine [11].

Chikamori *et al* [12], suggested that the ligation of the root of the appendix should be only moderately tight so as not to cause any ischemic change to the stump, indicated by discoloration or edema. Early in our study, tight closure of the loop on edematous base resulted in cutting or tearing of tissues, which necessitates conversion to open surgery and transfixing the appendicular stump and inversion by purse string suture.

The appendicular stump has been secured by different ways during LA, including the use of mechanical endostapler [13], endoligature (Endoloop) [14] [15], metal endoclips [16] [17], polymeric endoclips [18] and intracorporeal suture [1]. Sahm *et al*, [19] and Billingham and Basterield, [20] in their studies reported that intracorporeal suturing is a safe alternative to the expensive linear stapler or to the less expensive endoloops and showed no significant difference in efficacy and safety [19]. But it needs training and good hand skills; preparation of extracorporeal handmade loop is a good alternative as

Table 1. Demographic data, comorbidities and operative findings

	Group L (n = 200)	Group C (n = 200)	P value
Age (years)	35.4 (18 - 41)	25.8 (16 - 44)	>0.05
Sex (female)	110 (55%)	130 (65%)	>0.05
Male	90 (45%)	70 (35%)	>0.05
Diabetes mellitus	5 (2.5%)	2 (1%)	>0.05
Ischemic heart disease	9 (4.5%)	10 (5%)	>0.05
Arterial hypertension	13 (6.5%)	15 (7.5%)	>0.05
Intraoperative complications	0 (0%)	0 (0%)	>0.05
Operation time (min)	49 (40 - 66)	35.4 (33 - 55)	<0.05
Hospital stay (days)	2.07 (5 - 15)	10 (5 - 15)	>0.05

Table 2. Complications of both techniques in the early period and over 6 months.

	Group L	Group C	P value
Bleeding	0	0	>0.05
Iatrogenic intestinal injury	0	0	>0.05
Small-bowel obstruction	0	0	>0.05
Conversion rate	4 (2%)	16 (8%)	<0.05
Fecal fistula	0	2	>0.05
Abdominal abscess	0	0	>0.05
Postoperative delay of intestinal sounds	0	2	>0.05
Wound infection	2 (1%)	1 (0.5%)	>0.05
Failure of the technique	4 (2%)	20 (10%)	<0.05
Readmission	0	2	>0.05
Reoperation	0	0	>0.05

it is easier and takes less time.

Kiudelis *et al.* [21] and Billingham and Basterield [20] reported that intracorporeal ligation is lower in cost than the endoloop technique. Compared with laparoscopic staplers, endolpoops have an advantage as they much cheaper than stapling devices [22], and intracorporeal suture is even cheaper than endoloops [21].

As commercially available titanium and absorbable clips can sustain a degree of intraluminal pressure and cannot be displaced by a pressure of 300 mgHg [23] and are low cost, their use is acceptable for secure closure of the appendiceal stump similar to that of cystic duct closure. Rickert *et al.* [24] used a titanium double-shanked clip in their study. It has the ability to secure appendix stumps with a diameter of up to 20 mm safely. Despite being an easy and safe technique, the disadvantage is the need for a 12.5-mm trocar for introducing the clip applicator we agreed with some authors' study results [6] [16] and [25] that using a titanium endoclip for appendiceal stump closure is

safe and associated with a shorter operation time in LA.

Extracorporeal handmade loop simplifies the procedure and provides a useful alternative to intra corporeal suturing for appendicular stump closure. One of disadvantages of the titanium clip closure technique is the presence of appendix with a wide base of more than 10 mm, as clips do not close all diameters of the appendix. The use of mechanical stapler can solve the problem; however, it was not used in our study and management was performed successfully by extracorporeal handmade loop.

In this study, the metal clip closure success rate was 90%, and the 10% failure was due to either a wide caliber base or cutting through the edematous appendicular base. Loop closure succeeded to securing 98% of the appendicular stump, and the failure was due to cutting through appendicular base. So, care must be taken during securing the base of the appendix because forcible firing of clips or tight ligation led to tissue break down.

From our study, the application of both techniques was found to be safe and cost effective, and there were no significant differences regarding complications**:** only two cases in group C had a delay in bowel sounds, which was not related to the technique used; also, the incidence of port-site skin infection was low in both techniques ($P > 0.05$). Fecal fistula occurred in 2 cases in group C, otherwise, no other specific complications related to either technique such as intestinal obstruction.

There was no significant difference of cost or hospital stay for both techniques, but both were noticeably cheaper than those performed by staplers or endoloops.

Both techniques were feasible and cost effective, especially in developing countries, and clipping is much easier than the looping but not safe and feasible in all cases.

6. Conclusion

Using extracorporeal handmade loop or the metallic clips to secure the appendicular stump is safe, feasible, and inexpensive methods. The loop takes a little more time in its preparation. Metallic clips are inappropriate for edematous wide base appendix, and may be slipped from their primary position or cut through edematous tissue.

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