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Efficacy of the LigaSure system vs UltraCision harmonic scalpel in laparoscopic appendectomy for the management of acute appendicitis

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KEY WORDS

harmonic scalpel, laparoscopic appendectomy, LigaSure

ABSTRACT

INTRODUCTION Acute appendicitis is the most common abdominal surgical emergency worldwide, with peak incidence between the second and third decades of life. Appendectomy, performed for over a century, remains the standard treatment.

AIM We aimed to compare the safety and efficacy of laparoscopic appendectomy using the LigaSure system vs UltraCision harmonic scalpel (HS).

MATERIALS AND METHODS This prospective comparative observational study was conducted from January 2023 to January 2025, and included 600 patients diagnosed with suspected acute appendicitis at 2 research centers. The patients were randomized into 2 equal groups: Group A (n = 300) underwent laparoscopic appendectomy using the UltraCision HS, and Group B (n = 300) underwent the procedure using the LigaSure system.

RESULTS All 600 procedures were completed laparoscopically without conversion to open surgery. Mean (SD) operative time was 27.4 (6.7) minutes (range, 24–49 min) for Group A and 28.1 (7.4) minutes (range, 25–51 min) for Group B. Mean hospital stay was 1.14 (0.53) days for Group A and 1.16 (0.47) days for Group B. No major complications occurred. Two cases of minor postoperative complication (fever) were recorded (1 in each group), both of which resolved completely within 1 week.

CONCLUSIONS Both the LigaSure system and UltraCision HS are safe and effective for laparoscopic appendectomy in acute appendicitis, resulting in short operative times, minimal postoperative pain, low complication rates, and brief hospital stays.

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INTRODUCTION Acute appendicitis is the most frequent abdominal surgical emergency worldwide, with a lifetime risk of 8.6% for men and 6.9% for women, peaking in incidence between the second and third decades of life.[1] Appendectomy has been the standard treatment for over a century,[2] performed either openly or laparoscopically.[3] The first successful laparoscopic appendectomy was performed by Kurt Semm in 1982.[4] Since then, laparoscopic appendectomy has gained popularity due to several advantages, such as fewer wound infections and postoperative complications, reduced postoperative pain, and shorter length of hospital stay (LOS).[5-9]

Common techniques for laparoscopic appendectomy include mesoappendix division using the LigaSure system (Medtronic, Minneapolis, Minnesota, United States; Valleylab, Boulder, Colorado, United States) or UltraCision harmonic scalpel (HS; Ethicon, Raritan, New Jersey, United States), followed by appendiceal stump closure with an endoloop or stapler. Other closure

TABLE 1 Characteristics of the study population

Parameter		Group A (n = 300)	Group B (n = 300)	*P* value
Sex	Men	160 (53.33)	180 (60)	0.1
	Women	140 (46.67)	120 (40)	
Age, y	Mean (SD)	37.65 (11.42)	40.16 (10.25)	0.33
	Range	21–56	19–58	
BMI, kg/m²	Mean (SD)	26.28 (8.7)	27.43 (2.4)	0.52
	Range	19.75–38.72	20.36–39.53	

Data are presented as number (percentage) unless indicated otherwise.

Abbreviations: BMI, body mass index

TABLE 2 Operative data and outcomes

Parameter		Group A (n = 300)	Group B (n = 300)	*P* value
Operative time, min, median (IQR)		27 (24–31)	26 (24–32)	0.71
Complicated appendicitis	Yes	297 (99)	296 (98.7)	0.69
	No	3 (1)	4 (1.3)	
Length of hospital stay, d	Mean (SD)	1.14 (0.53)	1.16 (0.47)	0.83
	Range	1–2	1–2	
Postoperative complications[a]	Fever	1 (0.34)	1 (0.34)	>0.99
	Intra-abdominal collection	0	1 (0.34)	

Data are presented as number (percentage) unless indicated otherwise.

a Seven patients (3 from Group A and 4 from Group B) were lost to follow-up and excluded from the postoperative complication analysis.

Abbreviations: IQR, interquartile range

methods include extracorporeal knots, clips, and intracorporeal ligation, though the optimal stump closure technique remains debated. HS uses ultrasonic energy to cut and coagulate tissue simultaneously. The LigaSure device is a bipolar electrosurgical instrument designed for vessel sealing in both open and laparoscopic surgery.[10-12]

AIM This study compared the efficacy of laparoscopic appendectomy using the LigaSure system vs UltraCision HS in reducing operative time, postoperative pain, and intra- and postoperative complications.

MATERIALS AND METHODS **Study design** This prospective comparative observational study included 600 patients with acute appendicitis, operated on from January 2023 to January 2025 in 2 research centers (Zagazig University Hospital and Al-Ahrar Teaching Hospital). The study adhered to the 2021 Strengthening the Reporting of Cohort, Cross-Sectional, and Case--Control Studies in Surgery criteria.[13] The patients presenting with acute right lower abdominal pain and diagnosed via clinical, laboratory, and radiological assessment were randomized using the closed envelope method into 2 groups: Group A (UltraCision HS + endoloop; n = 300) and Group B (LigaSure system + endoloop; n = 300). This study included 260 women and 340 men. All patients presented with clinically, laboratory, and radiographically confirmed acute appendicitis. All participants were aged between 18 and 60 years. We excluded individuals with complicated acute appendicitis in the form of appendicular mass or abscess, previous multiple open abdominal surgeries, economic constraints, or preference for open appendectomy.

Patient selection During the study period, a total of 673 patients with suspected acute appendicitis were assessed for eligibility. Of these, 73 were excluded based on our criteria: 41 had complicated appendicitis (mass or abscess), 19 had a history of multiple previous open abdominal surgeries, and 13 were excluded due to economic constraints or a preference for open surgery. This resulted in a final cohort of 600 patients who were randomized. Of these, 436 patients were treated at the emergency surgery unit of the Zagazig University Hospital, and 164 were treated at the emergency surgery unit of the Al-Ahrar Teaching Hospital. Using the closed envelope method, the participants were randomly allocated into 2 equal groups (n = 300 each). Group A underwent laparoscopic appendectomy utilizing UltraCision HS and an endoloop, while Group B underwent the procedure using the LigaSure system and an endoloop. No conversions to open surgery were required. All 600 procedures were completed laparoscopically. However, 7 patients (3 from Group A and 4 from Group B) were lost to follow-up before the 1-month postoperative visit. Therefore, the final analysis of postoperative outcomes was performed on 593 patients.

A clinical diagnosis of noncomplicated acute appendicitis was made based on a complete medical history—including typical symptoms, such as recent right lower quadrant or periumbilical pain, nausea, vomiting, anorexia, or low-grade fever—and physical examination findings, such as right iliac fossa tenderness, guarding, a positive McBurney sign, or a positive cough test. Laboratory investigations for all patients included a complete blood count, C-reactive protein levels, and, for women of reproductive age, a pregnancy test. To confirm the diagnosis, exclude other causes of acute abdomen, and—most importantly—rule out complicated appendicitis (eg, appendiceal abscess, phlegmon, or generalized peritonitis), all patients underwent ultrasonography with or without contrast-enhanced abdominopelvic computed tomography (CT).

After a detailed explanation of the diagnosis, surgical procedure, benefits, risks, and potential complications, written informed consent was obtained from all eligible participants. Preoperative management included intravenous fluid administration and prophylactic broad-spectrum intravenous antibiotics (2 g of ceftriaxone). The patients were kept nil per os, and surgery was completed within 24 hours of diagnosis and initial management.

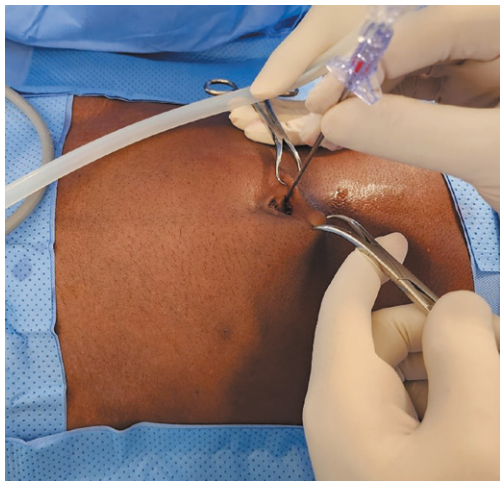

FIGURE 1
Pneumoperitoneum closure using a Veress needle

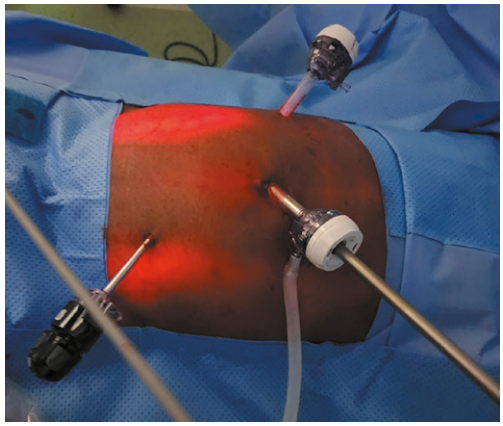

FIGURE 2 Port placement

Surgical procedure The procedure was performed with the patient in the supine position under general anesthesia. Following standard abdominal preparation and draping, 3 trocars were inserted. Pneumoperitoneum was established using a Veress needle, after which a 10-mm umbilical trocar was placed. A 5-mm operating port was then positioned in either the right or left iliac fossa, based on the intraoperative location of the appendix and surgeon preference. A second 5-mm operating port was placed in the suprapubic region.

After diagnostic laparoscopy to identify the appendix and assess for any associated pathology, the mesoappendix was coagulated, sealed, and divided using either the UltraCision HS (Group A) or the LigaSure system (Group B). The appendiceal base was subsequently ligated with an endoloop. Following specimen extraction, the abdomen was deflated under direct visualization and all trocars were removed. The skin incisions were closed in layers using Monocryl 4–0 suture (Ethicon).

The operating nurse recorded the duration of each procedure. All specimens were sent for histopathological analysis. Postoperatively, the patients were allowed small amounts of water, and were started on a liquid diet after 12 hours. Antibiotics were continued for at least 3 days only in cases of significantly inflamed or perforated appendices. Early ambulation was encouraged to promote bowel function. The patients from both groups were discharged 1 to 2 days after surgery.

Statistical analysis Categorical variables are presented as number (percentage). Continuous variables are presented as mean (SD) and median (interquartile range). The normality of continuous variables was assessed using the Shapiro–Wilk test. For intergroup comparisons, the independent samples *t* test was used for normally distributed data, and the Mann–Whitney test for non-normally distributed data. Categorical variables were compared using the Pearson χ^2 test or the Fisher exact test, as appropriate. All tests were 2-tailed, and a *P* value below 0.05 was considered significant. All analyses were performed using SPSS Statistics software, version 22.0 for Windows (IBM Corp., Armonk, New York, United States).

Ethics The study was approved by the Institutional Review Board of the Zagazig University (ZU-IRB#1419/17-6-2025), registered at ClinicalTrials.gov (NCT07091110) and the Pan African Clinical Trials Registry (PACTR.37046), and conducted according to the guidelines of the Declaration of Helsinki.

RESULTS The study initially included 600 participants (260 women and 340 men) diagnosed with acute appendicitis based on clinical, laboratory, and radiological findings. Seven patients were lost to follow-up, leaving 593 patients for the final analysis of postoperative outcomes. Patient demographics and baseline characteristics are summarized in **TABLE 1**. Histopathological examination confirmed acute catarrhal appendicitis in 490 patients and acute suppurative appendicitis in 110 individuals. Preoperative laboratory investigations supported the diagnosis in all patients, with mean (SD) leukocyte count of 14.5 (3.2) $\times 10^3/\mu l$ and mean (SD) C-reactive protein level of 4.58 (2.25) mg/l, confirming an inflammatory response.

Mean (SD) operative time was 27.4 (6.7) minutes (range, 24–48 min) in Group A and 28.1 (7.4) minutes (range, 25–51 min) in Group B. No intraoperative complications, such as hemorrhage or visceral injury, occurred in either group (**TABLE 2**).

Despite intraoperative findings of early appendiceal phlegmon or a small abscess in 3 patients in Group A and 4 in Group B, all procedures were completed laparoscopically without conversion to open surgery.

Postoperatively, 1 patient in Group A presented 1 week after surgery with fever, vomiting, and abdominal pain. Intravenous contrast-enhanced abdominal CT showed a small fluid collection (1 cm × 3 cm) in the right iliac fossa. The patient was managed successfully with intravenous ciprofloxacin (500 mg twice daily) and metronidazole (500 mg twice daily) for 2 days, followed by 1 week of oral antibiotics, with no further issues.

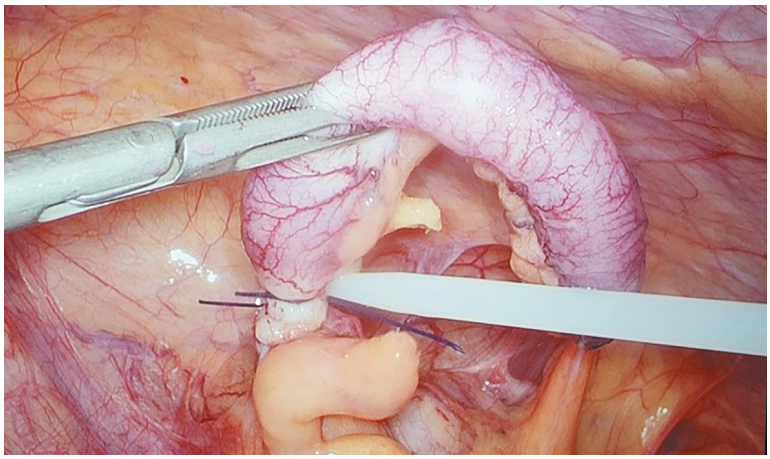

FIGURE 3 Endoloop ligation and securing the base of the appendix

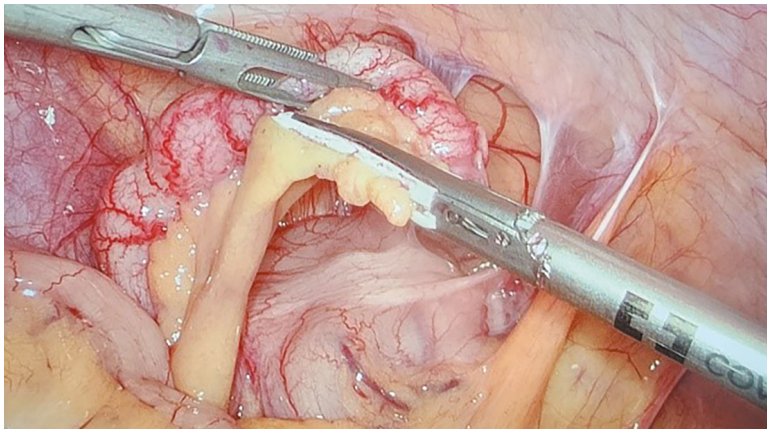

FIGURE 4 Dissection of the mesoappendix using the LigaSure sealing device

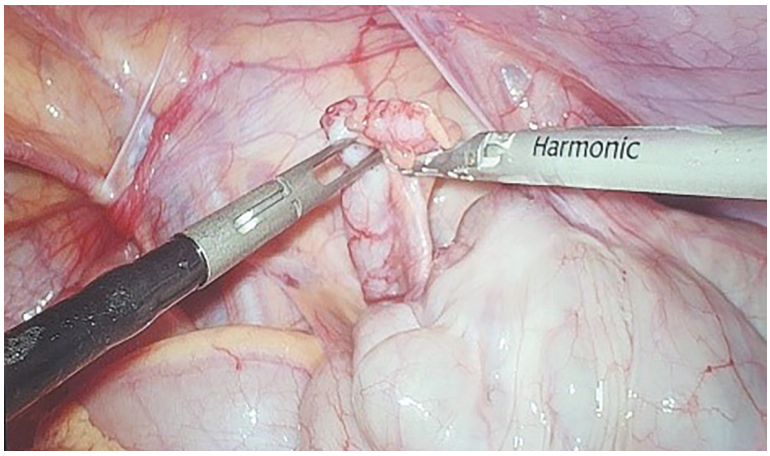

FIGURE 5 Dissection of the mesoappendix using the harmonic sealing device

In Group B, 1 patient presented on postoperative day 4 with fever and abdominal pain. Imaging identified a moderate fluid collection (4 cm × 5 cm) in the right iliac fossa, which was treated with ultrasound-guided drainage and a 3-day course of intravenous ciprofloxacin (500 mg twice daily) and metronidazol (500 mg twice daily). The patient improved and was discharged on oral antibiotics for 1 week without recurrence. No surgical site infections were documented in either group. All patients were followed-up in the surgical outpatient clinic for 1 month, during which no further complications were reported.

DISCUSSION Laparoscopic appendectomy provides several advantages over the open approach, including a lower risk of wound infection, less postoperative pain, shorter LOS, and improved quality of life scores.[14-16]

The utility of the LigaSure system in laparoscopic appendectomy has been explored in several experimental studies. Elemen et al[17] demonstrated in a rat model that LigaSure resulted in better healing, less inflammation, quicker recovery, and tensile strength comparable to suture ligation. Similarly, Souza et al[18] reported in a rabbit model that the LigaSure system achieved adequate coagulation and transection, with subsequent fibrosis of the appendiceal stump in all cases.

Both the electrothermal bipolar-activated vessel sealing systems (such as LigaSure) and ultrasonic systems (HSs) have been shown to reduce operative time, as compared with conventional hemostatic techniques. Some comparative studies have noted a marginal decrease in surgical time when using HSs relative to LigaSure devices.[19,20] In a clinical series by Helpman et al,[21] laparoscopic appendectomy was performed using the LigaSure system in 14 patients undergoing surgery for gynecologic malignancies, with no major intraoperative or postoperative complications and no conversions to laparotomy.

Although numerous studies have evaluated the efficacy of these devices in gynecological, colorectal, and endocrine surgery, data from randomized trials specifically focusing on their use in laparoscopic appendectomy are scarce.[22-26]

The present study aligns with existing evidence, demonstrating no significant differences between the LigaSure system and the UltraCision HS in laparoscopic appendectomy in terms of mean operative time, LOS, or intra- and postoperative complication rates. However, it is worth noting that, consistent with earlier reports, a slight reduction in operative time was observed with the UltraCision HS.

Previous comparative studies have reported similar findings. Campagnacci et al[27] observed in colorectal surgery that, while the LigaSure system was associated with less bleeding, operative times did not differ significantly between the 2 devices. Likewise, Yavuz et al,[28] in a randomized trial of 24 laparoscopic appendectomies, found no significant differences between the techniques. Rimonda et al,[29] after reviewing 140 patients, concluded that both LigaSure devices and HSs were safe and effective for laparoscopic colorectal surgery, with no differences in operative time or perioperative morbidity.

CONCLUSIONS The use of both the UltraCision HS and the LigaSure system as energy devices for

mesoappendix dissection in laparoscopic appendectomy is safe and efficient for treating acute appendicitis, demonstrating comparable outcomes in terms of LOS, postoperative pain, and intra- and postoperative complications. Nevertheless, both procedures are costly, which may be a burden for the patient.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT MAE: data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing the original draft, review, and editing. AAE, ESA, ASA, IAH, MMK, MR, AA, and AB: data curation, investigation, methodology, supervision, and validation. MIF: formal analysis, supervision, visualization, review, and editing.

CONFLICT OF INTEREST None declared.

AI STATEMENT Artificial intelligence was not used in the preparation of this manuscript.

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JOURNAL INFORMATION

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