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ORIGINAL PAPER

Efficacy of LigaSure versus Harmonic scalpel US in laparoscopic appendectomy in management of acute appendicitis

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Abstract

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

Aim: Compare the safety and efficacy of laparoscopic appendectomy using LigaSure versus the Harmonic scalpel.

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 two research centers. Patients were randomized into two equal groups: Group A (n = 300) underwent laparoscopic appendectomy using a Harmonic scalpel, and Group B (n = 300) underwent the procedure using LigaSure.

Results: All 600 procedures were completed laparoscopically without conversion to open surgery. The mean 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. The 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. One minor postoperative complication (fever) was recorded in each group, both of which resolved completely within one week.

Conclusions: Both LigaSure and the Harmonic scalpel 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.

Key words

harmonic scalpel, laparoscopic appendectomy, ligasure

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 Semm in 1982 [4]. Since then, laparoscopic appendectomy has gained popularity due to advantages such as fewer wound infections, less postoperative pain, shorter hospital stays, and reduced postoperative complications [5-9].

Common techniques for laparoscopic appendectomy include mesoappendix division using LigaSure or a Harmonic scalpel (HS), followed by appendiceal stump closure with an endoloop or stapler. Other closure methods include extracorporeal knots, clips, and intracorporeal ligation, though the optimal stump closure technique remains debated. The Harmonic scalpel uses ultrasonic energy to cut and coagulate tissue simultaneously. LigaSure is a bipolar electrosurgical device designed for vessel sealing in both open and laparoscopic surgery [10-12].

Aim

This study compares the efficacy of laparoscopic appendectomy using LigaSure versus the Harmonic scalpel in reducing operative time, postoperative pain, and intraoperative and postoperative complications.

Materials and methods

Study design This prospective comparative observational study included 600 patients with acute appendicitis from January 2023 to January 2025 at two research centers. The study adhered to the STROCSS 2025 criteria [29]. Patients presenting with acute right lower abdominal pain and diagnosed via clinical, laboratory, and radiological assessment were randomized using the closed

envelope method into two groups: Group A (Harmonic scalpel + endoloop) and Group B (LigaSure + endoloop).

Ethical approval The study was approved by the Institutional Review Board of ## University (ZU-IRB#. #/##), ClinicalTrials.gov (NCT###), and the Pan-African Clinical Trials Registry (PACTR.###).

Inclusions criteria This study included 260 female and 340 male patients. All patients presented with clinically, laboratory and radiographically confirmed acute appendicitis, during the period from January 2023 to January 2025 (the study period). All of whom were between the ages of 18 and 60.

Exclusions criteria We excluded patients with complicated acute appendicitis as appendicular mass or abscess. Patients with previous multiple open abdominal surgeries, economic constraints, or preference for open appendectomy were also excluded.

Patient workup and selection During the study period, a total of 673 patients with suspected acute appendicitis were assessed for eligibility. Of these, 73 patients 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 ### University Hospitals, and 164 patients were treated at the emergency surgery unit of ### Teaching Hospital. Using the closed envelope method, patients were randomly allocated into two equal groups of 300 each. Group A underwent laparoscopic appendectomy utilizing a Harmonic scalpel and endoloop, while Group B underwent the procedure using LigaSure and an endoloop. No conversions to open surgery were required. All 600 procedures were completed laparoscopically. However, seven patients (three from Group A and four from Group B) were lost to follow-up

before the one-month postoperative visit. Therefore, the final analysis of postoperative outcomes was performed on 593 patients.

A clinical diagnosis of non-complicated 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's sign, or a positive cough test. Laboratory investigations for all patients included a complete blood count (CBC), C-reactive protein (CRP) level, 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 (e.g., 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 patients. Preoperative management included intravenous fluid administration and prophylactic broad-spectrum intravenous antibiotics (Ceftriaxone 2g). Patients were kept nil per os (NPO), and surgery was completed within 24 hours of diagnosis and initial management.

Surgical procedure The procedure was performed with the patient in the supine position under general anesthesia. Following standard abdominal preparation and draping, three 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 LigaSure (Group B) or Harmonic scalpel (Group A). 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. The operating nurse recorded the duration of each procedure. All specimens were sent for histopathological analysis. Postoperatively, patients were allowed small sips of water and started on a liquid diet after 12 hours. Antibiotics were continued for at least three days only in cases of significantly inflamed or perforated appendices. Early ambulation was encouraged for all patients to promote bowel function. Patients in both groups were discharged from the hospital 1 to 2 days after surgery.

Statistical analysis Categorical variables are presented as number (percentage). Continuous variables are presented as mean ± standard deviation (mean SD) and median (range). The normality of continuous variables was assessed using the Shapiro-Wilk test. For comparisons between the two groups, the independent samples Student's *t*-test was used for normally distributed data, and the Mann-Whitney U test for non-normally distributed data. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate. All tests were two-tailed, and a *P* value of less than 0.05 was considered statistically significant. All analyses were performed using SPSS version 22.0 for Windows (IBM Corp., Armonk, NY, USA).

Results

This study initially included 600 patients (260 females, 340 males) 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 patients. Preoperative laboratory investigations supported the diagnosis in all patients, with a mean leukocyte count of 14.5 (3.2) x $10^3/\mu L$ and a mean C-reactive protein level of 4.58 (2.25) mg/L, confirming an inflammatory response.

The mean 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 three patients in Group A and four in Group B, all procedures were completed laparoscopically without conversion to open surgery.

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

In Group B, one patient presented on postoperative day four with fever and abdominal pain. Imaging identified a moderate fluid collection (4 × 5 cm) in the right iliac fossa, which was treated with ultrasound-guided drainage and a three-day course of intravenous ciprofloxacin and metronidazole. The patient improved and was discharged on oral antibiotics for one week without recurrence.

No surgical site infections were documented in either group. All patients were followed in the surgical outpatient clinic for one 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 hospital stays, and improved quality-of-life scores [13-15].

The utility of LigaSure in laparoscopic appendectomy has been explored in several experimental studies. Elemen et al. demonstrated in a rat model that LigaSure resulted in better healing, less inflammation, quicker recovery, and comparable tensile strength compared to suture ligation [16]. Similarly, Souza et al. reported in a rabbit model that LigaSure achieved adequate coagulation and transection, with subsequent fibrosis of the appendiceal stump in all cases [17].

Both LigaSure and the Harmonic scalpel have been shown to reduce operative time compared to conventional hemostatic techniques. Some comparative studies have noted a marginal decrease in surgical time when using the Harmonic scalpel relative to LigaSure [18,19]. In a clinical series by Helpman and Covens, laparoscopic appendectomy was performed using LigaSure in 14 patients undergoing surgery for gynecologic malignancies, with no major intraoperative or postoperative complications and no conversions to laparotomy [20].

Although numerous studies have evaluated the efficacy of these devices in gynecological, colorectal, and endocrine surgery, there remains a paucity of data from randomized trials specifically focusing on their use in laparoscopic appendectomy [21-25].

The present study aligns with existing evidence, demonstrating no statistically significant difference between LigaSure and the Harmonic scalpel in laparoscopic appendectomy regarding mean operative time, length of hospital stay, or intraoperative and postoperative complication rates. It is worth noting, however, that a slight reduction in operative time was observed with the Harmonic scalpel, consistent with earlier reports.

Previous comparative studies have reported similar findings. Campagnacci et al[26] observed in colorectal surgery that while LigaSure was associated with less bleeding, operative times did not differ significantly between the two devices. Likewise, Yavuz et al[27], in a randomized trial of 24 laparoscopic appendectomies, found no statistically significant differences between the techniques. Rimonda et al[28], after reviewing 140 patients, concluded that both LigaSure and the Harmonic scalpel are safe and effective for laparoscopic colorectal surgery, with no significant differences in operative duration or perioperative morbidity.

Conclusions The use of both the Harmonic Scalpel and LigaSure as energy devices for mesoappendix dissection in laparoscopic appendectomy is safe and efficient for treating acute appendicitis. Demonstrating comparable outcomes with regard to of a shorter hospital stay, less postoperative pain, and fewer intraoperative and postoperative complications; nevertheless, both operations have the drawback of being costly, which could put the patient in a difficult financial situation.

Article information

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Conflicts of interest The authors declare no conflict of interest.

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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	36.54 (21–56)	38.76 (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)	
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				

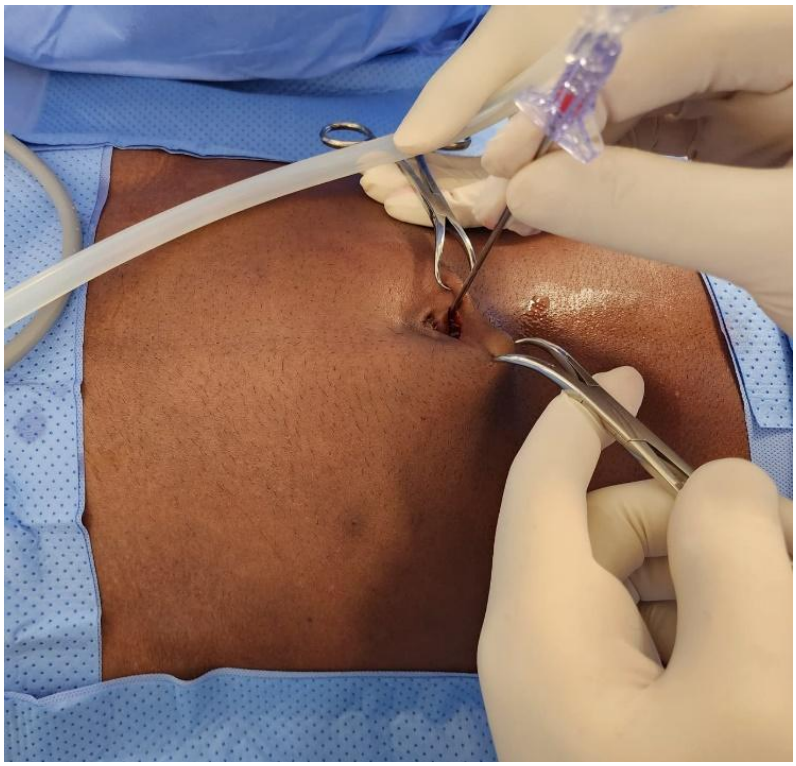

Figure 1 Shows pneumoperitonium using close technique by Veress needle

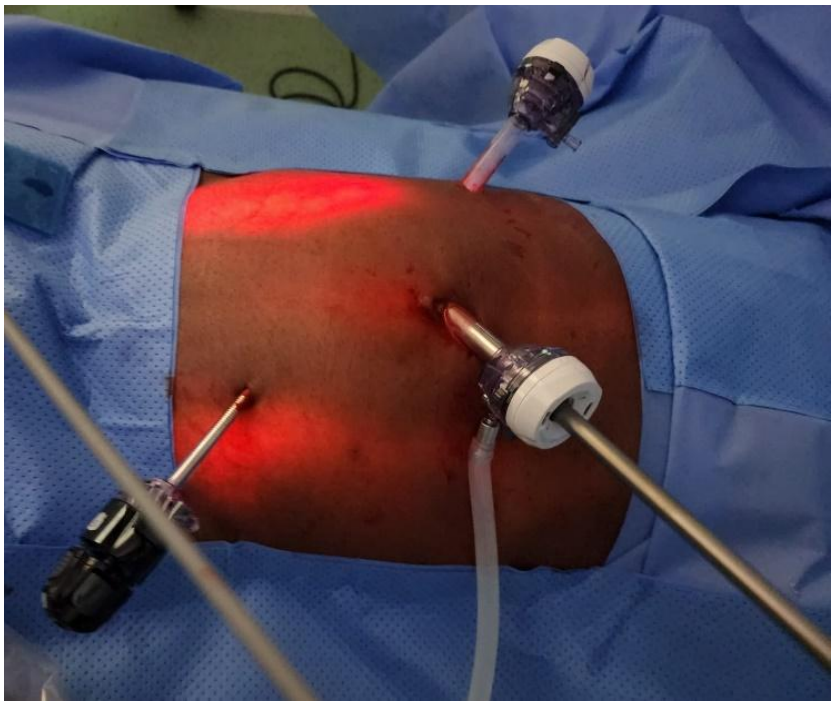

Figure 2 Shows ports placement

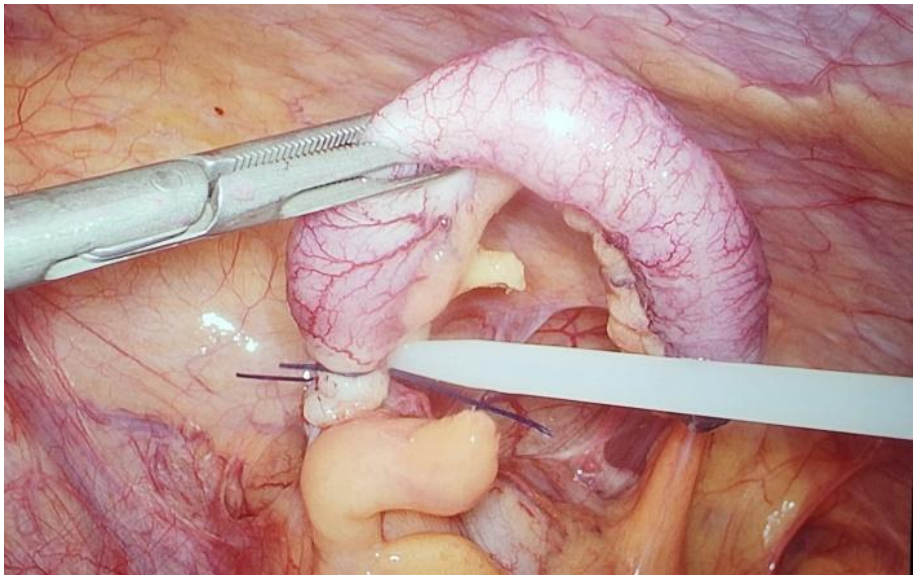

Figure 3 Shows Endoloop ligation and securing the base of the appendix

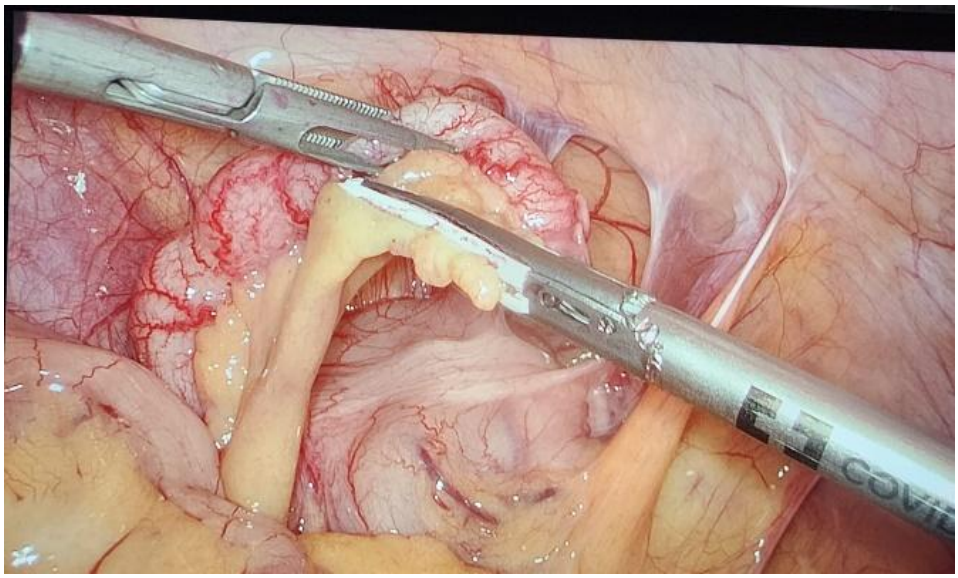

Figure 4 Shows dissection for Mesoappendix using LigaSure sealing devise

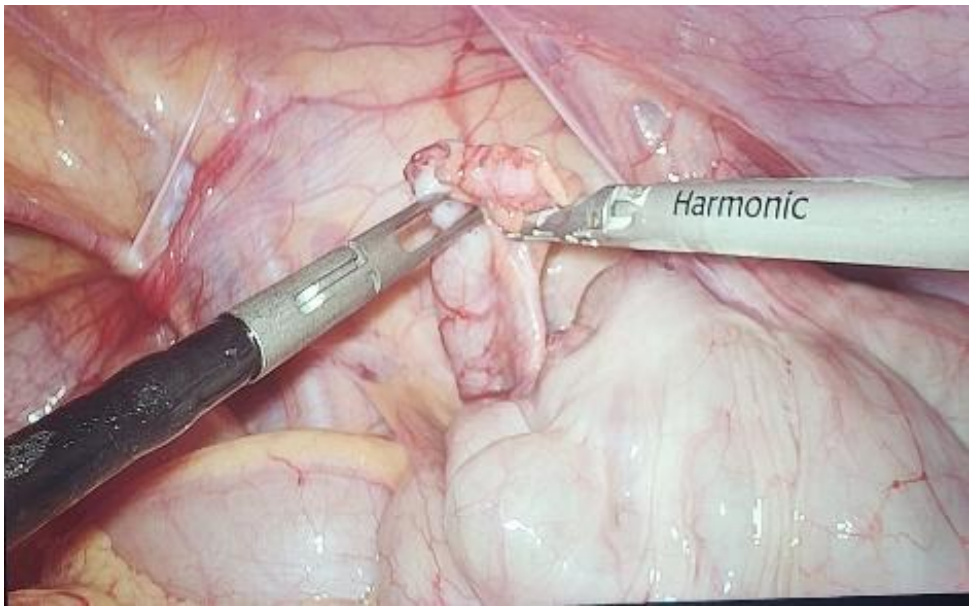

Figure 5 Shows Dissection of the Mesoappendix using Harmonic Sealing device

Short title: LigaSure versus Harmonic scalpel US in laparoscopic appendectomy