

Safety and feasibility of cystic artery control with bipolar electrocauterization during laparoscopic cholecystectomy

Mohie El-Din M. Madany^{a,b}, Mansor M. Kabbash^b, Hassan A. Abdallah^{a,b}

^aDepartment of General Surgery, Faculty of Medicine, Aswan University, Aswan,

^bDepartment of Maxillofacial Surgery, Faculty of Dentistry, Sphinx University, Assiut, Egypt

Correspondence to Mohie El-Din M. Madany, MD, Department of General Surgery, Faculty of Medicine, Aswan University, Aswan 81528, Egypt. Tel (office): 0020952603500, 0020952603501, 0020952603502, 00201141341342, 00201224497380; Fax: 097/2430767; E-mail: mohie.madany@med.aswu.edu.eg

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Background

Securing the cystic artery in laparoscopic cholecystectomy can be achieved with clips, electrocautery, and ultramodern vessel-sealing energy devices. Bipolar electrocoagulation of cystic artery is safe and a cost-effective measure in developing countries.

Patients and methods

The rationale of this current prospective study was to establish the safety and feasibility of bipolar electrocautery in securing cystic artery during laparoscopic cholecystectomy in the local setting. Patients who were eligible for laparoscopic cholecystectomy at the Aswan University Hospital's General Surgery Department were included.

Results

One hundred twenty patients were included in our study. Most of the participants were females, representing 93.33% of patients. The mean age of participants was 39.93±9.97 years, and 95.83% were overweight or obese. The mean±SD operative time was 88.57±28.06 min, and the median (interquartile range) was 84 min (33.25 min). Also, the mean±SD hospital stay was 1.12±0.57 days, and the median (interquartile range) was 1 (0) day. There was no intraoperative bleeding from the cystic artery nor from the right hepatic artery. No visceral injury was encountered. The success rate of the operation was 100%. None needed to be redone. No case needed conversion to open surgery.

Conclusion

In conclusion, in resource-constrained settings where the harmonic scalpel and all advanced bipolar instruments like ENSEAL and Legasure raise issues regarding cost and accessibility, bipolar diathermy is effective in hemostatic control of the cystic artery during laparoscopic cholecystectomy.

Keywords:

bipolar diathermy, cholecystectomy, cystic artery, laparoscopy, success rate

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Introduction

Laparoscopic surgery has become the gold standard of care for surgical operations across various disciplines due to its ability to decrease perioperative complications, expedite recovery, and yield superior cosmetic outcomes [1]. Laparoscopic cholecystectomy is a widely practiced procedure for symptomatic cholelithiasis and all other indications for gall bladder removal [2]. It is now the accepted method of choice for practically all abdominal procedures. When American surgeon Ruddock initially proposed laparoscopic surgery in the early 1930s, he discussed how it was a better diagnostic technique than open surgery [3,4]. Professor Mühe of Böhlingen performed the first laparoscopic procedure in 1985 [5].

In the beginning, there was a significant rise in morbidity associated with this new treatment, especially iatrogenic biliary damage, and arterial hemorrhage. Cystic arteries most frequently originate

from the right hepatic artery but can also arise from the common hepatic, celiac trunk, right gastric, superior mesenteric, and other arteries. The course and length of the cystic artery in the Calot's triangle might vary; thus, hemostasis is crucial since the cystic artery is the most common cause of postoperative bleeding following laparoscopic cholecystectomy and can produce torrential hemorrhage if not ligated properly [6–8].

Securing the cystic artery can be achieved with clips, electrocautery, and ultra-modern vessel-sealing energy devices [9–13]. Bipolar electrocoagulation of the cystic artery is a safe and cost-effective measure in developing countries [14,15].

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The rationale of this current prospective study was to establish the safety and feasibility of bipolar electrocautery in securing the cystic artery during laparoscopic cholecystectomy in the local setting.

Patients and methods

Study design

The study complied with the most recent version of the Declaration of Helsinki and adopted the well-recognized GCP criteria. Furthermore, it was authorized by the Local Ethics Committee and complied with all applicable national rules and regulations. This study was planned under the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) Statement checklist, as a single-group quasi-experimental investigation [16].

The study, approved by the institutional review board (IRB), Faculty of Medicine, Aswan University, was conducted on patients who attended the general surgery outpatient clinic at Aswan University Hospital from June to August 2023. Every participant who visited the center, before being included in the study, received a thorough explanation in Arabic regarding the procedure and its objective, and each participant signed an informed consent form.

The study covered all cases – male or female, 18 years of age or older – that come to the center and are qualified for cholecystectomy either elective or emergency. However, every patient declined to participate, and individuals with mental impairments preventing them from undergoing the routine follow-up were excluded. During the operation, no patient had adhesions in the Calot's triangle or very short cystic arteries to be excluded from the study.

Every patient underwent a thorough history-taking process that covered their medical, surgical, and personal history (age, sex, and unique habits). The patients were prepared to undergo the procedure after being admitted to the hospital.

Technique description

Following a preoperative workup, a single surgeon with at least 10 years of experience in minimally invasive surgery performed a laparoscopic cholecystectomy while under general anesthesia.

The standard technique four-port technique was used to do the surgery. According to the 'American'

approach, the surgeon stood to the left of the patient, the first assistant to the right of the patient, and the person operating the laparoscopic video camera to the left of the surgeon. Using a Veress needle and CO₂ gas, pneumoperitoneum was created. A laparoscopic port was then blindly implanted in its place.

The cystic artery, and so Calot's triangle, is situated within the dissected hepatocystic triangle, which is the ventral portion of the region bounded by the gallbladder wall and cystic duct, the liver edge, and the common hepatic duct. The hepatocystic triangle was maximally extended by retracting the gallbladder's infundibulum inferiorly and laterally while maintaining the fundus under traction in a superior and medial position. Following the dissection of the Calot's triangle, the cystic duct was cut. A bipolar diathermy forceps was utilized attached to 400 HP diathermy in coagulation mode to cauterize the cystic artery (Fig. 1), then the artery was divided with a scissor or a monopolar hook (Fig. 2) in all cases, directly lateral to the Calot's lymph node, without the need of clips or ligatures. Any indications of bleeding or bile leakage were observed over the split cystic duct and artery stumps.

After the cholecystectomy was carried out using standard procedure, the gall bladder was removed. Hemostasis was kept stable throughout the process. Using suction, the blood clots and debris were extracted. The cystic duct stump bile leakage and cystic artery stump hemorrhages were reexamined. For postoperative analgesia, bupivacaine was administered into each port incision. The skin incisions were closed with Xylon 3-0. There were no instances of biliary leakage or postoperative hemorrhage among the patients. More than 100 ml of fresh blood was considered a significant bleed. The patients were all discharged from the hospital after being judged well. The duration of hospitalization and any problems following surgery were noted and tracked.

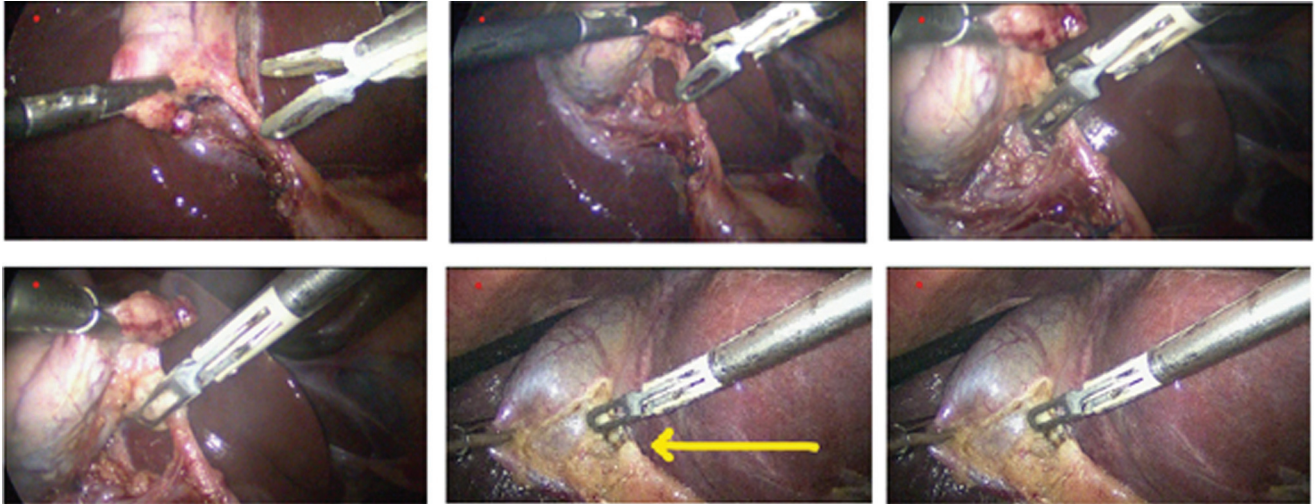
Follow-up

All participants were followed-up postoperatively for any emergent events related to the operation. Follow-up was made by seeing all the cases 1 day, 1 week, and 1 month after the surgery; then, a telephone call for all cases after 2–3 months.

The outcome variables

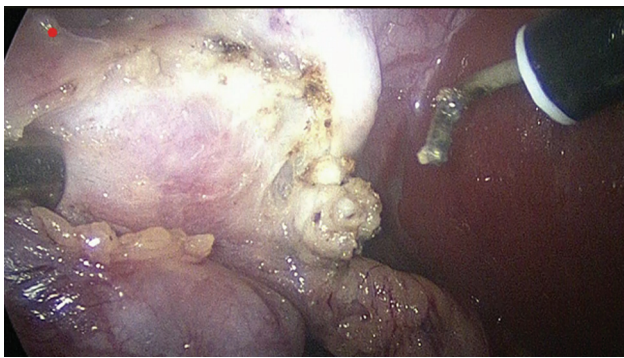
This study's main goal is to assess the new method in terms of surgical success, the conversion rate, length of the procedure, complications (intraoperative cystic artery bleed, intraoperative right hepatic artery

Figure 1



Steps of cauterization of the cystic artery.

Figure 2



Division of the cystic artery with hook monopolar diathermy after securing it with bipolar diathermy.

injury, or intraoperative major bile duct injury), postoperative discomfort [measured by visual analog scale (VAS) score], hospital stay, and postoperative complications (such as infection, seroma, hematoma) were the secondary outcome variables.

Statistical analysis

According to the study by Emmi and Suhas [6], the incidence of intraoperative cystic artery bleeds was 0% in the electrocautery and 13.3% in the clips group. In the current study, with the use of bipolar diathermy, we expect the same results of 0% incidence. Thus, with a significance level of 95% and a power of 80%, the calculated sample size was 108 participants. To allow for a dropout rate of 10%, the sample size was increased to 120 participants.

Continuous data were presented in mean±SD or median+interquartile range (IQR) according to the normality test of the variable distribution. For

qualitative data, we used numbers and percentages. SPSS software (Statistical Package for the Social Sciences, version 25.0; SSPS Inc., Chicago, Illinois, USA) was used for the statistical analyses.

Results

In this study, 137 patients eligible for laparoscopic cholecystectomy were asked to participate; of them, 17 participants declined to participate, leaving 120 participants who enrolled and followed up.

Baseline characteristics

In this study, 120 participants were enrolled and followed up postoperatively, with an average age of 39.93±9.97 years. The majority of cases were female 112 (93.33%). Only five (4.17%) cases had normal weight, 37 (30.83%) were 'overweight,' and 78 (65.00%) were 'obese.' The average BMI was 32.15 ±4.19 kg/m².

Only 12 (10%) had hypertension, 12 (10%) diabetes mellitus, and five (4.17%) IHD. More than half of the cases, 62 (51.67%) were ASA II, 54 (45%) were ASA I and only four cases (3.33%) were ASA III.

Operative details

All cases underwent laparoscopic cholecystectomy.

Most cases, 85 (70.83%) had chronic calculator cholecystitis. On the other hand, only four (3.33%) cases had gangrenous gall bladder, two (1.67%) cases had gallstone pancreatitis, and two (1.67%) cases had perforated gall bladder. All other findings are shown in Table 1.

Table 1 Baseline characteristics

Categorical variables		
Indication [<i>n</i> (%)]		
Chronic calculator cholecystitis	85	(70.83)
Acute calculator cholecystitis	8	(6.67)
Mucocele of the gallbladder	5	(4.17)
Pyocele of the gallbladder	5	(4.17)
Symptomatic gallbladder polyps	5	(4.17)
Adenomyomatosis of the gallbladder	4	(3.33)
Gangrenous gallbladder	4	(3.33)
Gallstone pancreatitis	2	(1.67)
Perforated gallbladder	2	(1.67)
Continuous variables		
	Age	BMI
Valid number	118	120
Mean	39.93	32.15
SD	9.97	4.19
Minimum	25.00	24.50
Lower quartile	31.00	29.00
Median	39.00	32.35
Upper quartile	48.00	35.73
Maximum	65.00	39.00
Interquartile range	17.00	6.73

As depicted in Table 2, the mean±SD operative time was 88.57±28.06 min, and the median (IQR) was 84 min (33.25 min). Also, the mean±SD hospital stay was 1.12±0.57 days, and the median (IQR) was 1 (0) day.

There was no intraoperative bleeding from the cystic artery or the right hepatic artery. No visceral injury was encountered.

The success rate of the operation was 100%. None needed to be redone. No case needed conversion to

open surgery. Also, there was no bile duct injury or bile leak.

Postoperative follow-up

The postoperative pain (VAS score) was mean±SD 1.89±0.73, and the median (IQR) was 2 (1), with a minimum VAS of 1 and a maximum of 3. Only two (1.67%) cases experienced seroma, two (1.67%) cases hematoma, and two (1.67%) cases port-site infection during 1 month of the postoperative period. No other complication was seen during the follow-up period.

Discussion

In 1986, Muhe [2] performed the first laparoscopic cholecystectomy. Laparoscopic cholecystectomy is the gold standard of care for cholecystolithiasis and other indications [9]. In the beginning, there was a significant rise in morbidity associated with this new therapy, especially iatrogenic biliary damage, and arterial hemorrhage. The surgeon must execute careful dissection and rely on his comprehensive awareness of the exact Calot's triangle identification and its anomalies to prevent damage to the extrahepatic biliary tree [17]. Several ways to handle the cystic artery during the procedure include clip application, monopolar and bipolar cautery, vascular sealers, and ultrasonic devices [6].

In the current study, most cases are females (93.33%). Also, female preponderance was observed in other studies by Emmi and Suhas [6] and Hugh *et al.* [18]. Also, the length of stay in the hospital was 1.12±0.57 days, and the duration of surgery was 88.57±28.06 min, comparable to the results of other studies [6,18].

Table 2 Operative and postoperative details

Categorical variables			
Postoperative complications	Frequency	%	
Seroma	2	1.67	
Hematoma	2	1.67	
PSI	2	1.67	
Continuous variables			
	Operative time (min)	Hospital stay (days)	VAS
Valid number	120	120	120
Mean	88.57	1.12	1.89
SD	28.06	0.57	0.73
Minimum	48.00	1.00	1.00
Lower quartile	67.75	1.00	1.00
Median	84.00	1.00	2.00
Upper quartile	101.00	1.00	2.00
Maximum	165.00	5.00	3.00
Interquartile range	33.25	0.00	1.00

VAS, visual analog scale.

Also, no incidences of intraoperative hemorrhage or bile leak were documented, which was mentioned in other studies [6]. However, two cases of bile leak and four cases of intraoperative cystic artery bleed were mentioned when clips were used in one study [6].

The success of diathermy in the current study without any incidence of complications like bile leakage, cystic artery injury, or right hepatic artery injury is consistent with those of Emmi and Suhas [6], Das *et al.* [19], Katri *et al.* [20], and Chauhan *et al.* [21], who investigated the use of cautery for cystic artery management [22].

On the other hand, in research involving patients undergoing laparoscopic cholecystectomy, Redwan [23] showed that the harmonic scalpel is equally successful as the cautery technique in hepatobiliary stasis with a shorter surgical time but is not cost-effective when compared to cautery in laparoscopic cholecystectomy.

Because the depth of burn with bipolar electrocautery is unpredictable, simple precautions such as staying close to the gall bladder wall during dissection, avoiding diathermy near metal clips on the cystic duct, and control of the cystic artery, preferably lateral to the cystic lymph node, can help to prevent injury [23]. Using only short bursts of the minimum energy required to maintain homeostasis is critical.

Regardless, it should be emphasized that the cautious application of electrocautery to regulate the cystic artery results in a shorter operative time. In other words, in the hands of a trained professional, bipolar electrocautery is a safer alternative to other surgical methods like clips.

Bipolar diathermy can secure a larger diameter blood vessel than monopolar diathermy. Cystic artery had different diameters. Sometimes, it is larger than the diameter secured safely with monopolar diathermy. So, bipolar can secure all cystic artery diameters. It has the advantage of less lateral thermal spread than the monopolar one. It has the advantage of no burn occurring at sites of nearby titanium-clipped structures. It is a reusable instrument, cheap, and cost-effective. Other methods like harmonic, which is ultrasonic waves, and all advanced bipolar like Ligasure, and ENSEAL are single-use and expensive. Bipolar diathermy can be used through any port 5 mm for hemostasis in the liver bed, and gall bladder, and also for adhesiolysis.

Due to the fact that titanium clips used in laparoscopic surgery are usually medium-large size; therefore, if the cystic artery is so large or small or any smaller branch from it, the clips may not be suitable, and the smaller or larger size may not be available. In addition, hemoclips are relatively expensive. Moreover, malfunctions of the clip applicator may occur more frequently than the diathermy. Finally, suture ligatures may not be suitable for securing smaller vessels and are time consuming.

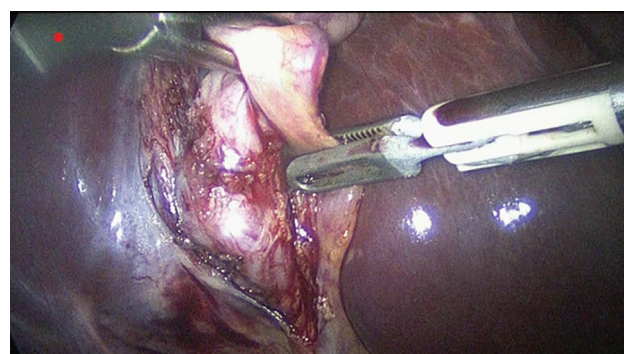
Bipolar diathermy in the current study showed no conversion as it played a significant role in controlling bleeding from the cystic artery and its branches, in addition to bleeding from the gall bladder and its bed. Also, in subtotal cholecystectomy, it played a significant role in controlling the bleeding from the gall bladder wall and in ablation of the mucosal lining of the part that will be left on the gall bladder bed in the liver. Bipolar diathermy did control bleeding from the port site, and site of insertion of the Verres needle. The bipolar forceps can grasp the tissues with a power grip as it has fine atraumatic serrations and also in dissection as its jaws are slim (Fig. 3).

This study has a number of limitations. First, it did not compare the diathermy to a traditional technique. However, this pilot study's goal was to assess the effectiveness and safety of bipolar diathermy. To further bolster the evidence supporting its efficacy and safety, this method will be tested in a randomized controlled trial against alternative approaches.

Conclusion

In conclusion, in resource-constrained settings where the harmonic scalpel and all advanced bipolar instruments like ENSEAL and Ligasure raise issues

Figure 3



Bipolar diathermy forceps can be used as a grasper.

regarding cost and accessibility, bipolar diathermy is effective in hemostatic control of the cystic artery during laparoscopic cholecystectomy. In order to validate our results, additional randomized control studies are required.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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