

Comparing the Effect of Electrocoagulation and Direct Pressure Application with Adrenaline-Soaked Gauze on Bleeding from Liver Bed during Laparoscopic Cholecystectomy

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Abstract: Liver bed bleeding during laparoscopic cholecystectomy may prolong operative time and increase the need for additional hemostatic measures. Electrocoagulation and adrenaline-soaked gauze pressure are commonly used methods, but comparative evidence remains limited. **Objective:** To compare the effectiveness of electrocoagulation and direct pressure application with adrenaline-soaked gauze for achieving hemostasis from the liver bed during laparoscopic cholecystectomy. **Methods:** This randomized controlled trial was conducted at the Department of General Surgery, National Hospital & Medical Centre, Lahore, from 5 May 2025 to 5 August 2025. A total of 150 patients aged 20–60 years undergoing elective laparoscopic cholecystectomy were randomized into two equal groups. Group A underwent electrocoagulation of the liver bed, while Group B received direct pressure using adrenaline-soaked gauze for five minutes. The primary outcome was secured hemostasis, while secondary outcomes included time to hemostasis, blood loss, operative time, need for additional hemostatic measures, and length of hospital stay. Categorical variables were compared using the chi-square test, while continuous variables were analyzed using the independent-samples t-test. A p-value ≤ 0.05 was considered statistically significant. **Results:** Secured hemostasis was achieved in 72 (96.0%) patients in the electrocoagulation group compared to 61 (81.3%) in the adrenaline gauze group ($p=0.006$). Mean time to hemostasis was significantly shorter in Group A (3.1 ± 1.2 minutes) than in Group B (5.4 ± 1.8 minutes; $p<0.001$). Mean blood loss (58 ± 22 vs. 98 ± 35 mL; $p<0.001$) and operative time (46.2 ± 8.5 vs. 54.7 ± 11.2 minutes; $p<0.001$) were also lower with electrocoagulation. Additionally, hemostatic measures were required less frequently in Group A (4.0% vs. 18.7%; $p=0.004$). Length of hospital stay was shorter in the electrocoagulation group (1.6 ± 0.7 vs. 2.8 ± 1.4 days; $p<0.001$). **Conclusion:** Electrocoagulation provides faster and more reliable hemostasis with reduced blood loss and shorter operative duration compared with adrenaline-soaked gauze, and may be considered the preferred method for liver bed bleeding control during laparoscopic cholecystectomy.

Keywords: Laparoscopic cholecystectomy, Electrocoagulation, Adrenaline gauze, Hemostasis

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Introduction

Laparoscopic cholecystectomy has been known to be the most efficient method of treating symptomatic gallstones (1). Laparoscopic cholecystectomy has since been improved, particularly in magnification and visualization, compared with open cholecystectomy, in terms of effectiveness and safety (3). Although laparoscopic cholecystectomy has its benefits, including reduced recovery and minimal pain after surgery, one should remember the possible risk of the minimally invasive procedure. It may result in biliary complications, including bile leakage, biliary fistula, jaundice, cholangitis, sepsis, and non-biliary complications, including hemorrhage, injury of surrounding structures, and intestinal perforation (4). The problem that is frequently encountered is bleeding in the liver bed, which might necessitate conversion to open cholecystectomy or re-operation in case it is realized post-procedure (5). Damage to the middle hepatic vein or arteries may happen during the dissection of the gallbladder with the liver bed, especially in cholecystitis cases. When bleeding occurs within a hepatic vein, it may be a serious condition, as it can lead to carbon monoxide embolism and shock. To avoid this, it is necessary to identify effective means of managing bleeding from the liver bed. Electrocoagulation, direct pressure, and ultrasonic coagulation are the most popular in this case (6). Various studies have compared electrocautery and ultrasonic coagulation (7,8).

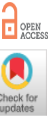
In everyday clinical practice, some techniques have been used to manage bleeding during laparoscopic cholecystectomy. The first-line method is

often electrocautery, which can coagulate small bleeders and provide hemostasis. Also, other hemostatic agents, such as oxidized regenerated cellulose or fibrin sealants, supplement electrocautery and provide additional control of bleeding (9,10). In cases where electrocautery and hemostatic agents are no longer effective, specialized surgical equipment is investigated. The technique employed depends on the degree of bleeding, the availability of equipment, and the surgeon's expertise. In most instances, the use of adjunctive measures, together with electrocautery, is sufficient (9,10).

The application of adrenaline-soaked dressings to wounds has raised considerable concern in the medical community, as it offers the potential to control bleeding and enhance wound healing. Adrenaline, or epinephrine, is a strong vasoconstrictor and, when used topically on wounds, is known to help control bleeding. Nevertheless, the literature on the correct usage of adrenaline soaks is not clearly structured, and medical workers have to maneuver through a complicated terrain of factors on whether to use this therapy method or not (11).

In one study, secure Intraoperative bleeding was obtained among 86.2/81.7 percent of patients on whom electrocoagulation was performed, as opposed to direct pressure being applied. i.e., p -value=0.35 (12). It was also reported in another study that Electrocauterization was superior to direct pressure in haemostasis of the liver in laparoscopic cholecystectomy. i.e., 96.0% vs. 85.0%. i.e., p -value=0.008 (13).

In another study, epinephrine-impregnated gauze was applied to control bleeding from the liver bed fossa and facilitate cholecystectomy (14).



Thus, this study aims to compare the effectiveness of electrocoagulation and direct pressure with adrenaline-soaked gauze in controlling bleeding from the liver bed during laparoscopic cholecystectomy.

Methodology

This Randomized controlled trial was conducted at the General Surgery Department, National Hospital & Medical Centre, Lahore, from 5th May 2025 to 5th August 2025. A total sample size of 150 patients was calculated, assuming 80% power and a 5% significance level, with an expected rate of secured hemostasis of 96% with electrocoagulation and 81.7% with direct pressure application, based on previous studies. As such, each group was assigned 75 patients. Simple random sampling was used to recruit participants, and the lottery method was used to assign them to groups. The study involved patients of either sex aged 20-60 years who were to undergo an elective laparoscopic cholecystectomy and had to meet the operational definition and provide written informed consent. To control confounding and perioperative risk, patients with upper abdominal surgery in the past, acute cholecystitis on ultrasonography (peri-cholecystic fluid or gallbladder wall thickness >5 mm), and bleeding disorders (INR >1.5), renal impairment (serum creatinine >2mg/dL), cirrhosis, and obstructive jaundice were excluded. Two groups were formed by randomly allocating eligible patients in a 1:1 ratio via lottery. Group A was treated with electrocoagulation of the liver bed to achieve hemostasis, and Group B was treated with direct pressure using gauze soaked in adrenaline solution (1 mg/mL). The allocation process was conducted immediately before surgery to minimize selection bias and ensure a balanced sample.

All patients were counseled on the study protocol, and informed consent was obtained after the institution's ethics review committee approved the protocol. Age, gender, and body mass index were recorded using a structured pro forma as baseline demographic and clinical information. All the surgeries were done under general anesthesia and the conventional four-port laparoscopic cholecystectomy technique to ensure that the procedure was consistent across all surgeries. After taking out the gallbladder at the liver bed, hemostasis was done as per the group allotted. In Group A, the bleeding surface was directly electrocoagulated. Group

B involved direct pressure on the liver bed with adrenaline-soaked gauze for five minutes. Intraoperative assessment of hemostasis. Bleeding that ceased within five minutes without further action was counted as secured hemostasis, and unsecured bleeding that continued beyond five minutes. In unwell hemorrhage, endoclips or endosuturing were utilized, or topical hemostatic agents, including oxidized regenerated cellulose, gelatin, or collagen, were used. In case proper control was not possible laparoscopically, open cholecystectomy was done. All intraoperative results, time taken to achieve hemostasis, and complications were noted. The primary outcome was hemostatic efficacy, defined as successful control of bleeding within 5 minutes. The secondary outcomes were the duration of operation, additional interventions (hemostatic agents or open surgical conversion), and complications during the operation or after open surgery.

All data were entered and analyzed using SPSS version 21. Quantitative variables such as age and BMI were expressed as mean ± standard deviation and range, while categorical variables such as gender and hemostasis outcome were presented as frequencies and percentages. The chi-square test was applied to compare efficacy between the two groups. Potential effect modifiers, including age, gender, and BMI, were controlled through stratification, followed by post-stratification chi-square testing. A p-value < 0.05 was considered statistically significant.

Results

Data were collected from 150 patients; the mean age was similar (41.5 ± 10.4 vs. 42.1 ± 11.1 years), with identical female representation in both groups (58.7%). Body mass index showed minimal variation (26.2 ± 3.3 vs. 26.6 ± 3.7 kg/m²). Most patients belonged to ASA Class I-II (84.0% vs. 81.3%). The prevalence of diabetes (24.0% vs. 26.7%), hypertension (29.3% vs. 32.0%), and smoking (21.3% vs. 24.0%) was comparable. Laboratory parameters, including hemoglobin (13.1 ± 1.2 vs. 13.0 ± 1.3 g/dL), INR (1.07 ± 0.11 vs. 1.08 ± 0.12), and serum creatinine (0.98 ± 0.21 vs. 1.01 ± 0.24 mg/dL), were also similar, confirming well-balanced groups at baseline.

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Electrocoagulation (n=75)	Adrenaline Gauze (n=75)
Age (years)	41.5 ± 10.4	42.1 ± 11.1
Female gender	44 (58.7%)	44 (58.7%)
BMI (kg/m ²)	26.2 ± 3.3	26.6 ± 3.7
ASA Class I-II	63 (84.0%)	61 (81.3%)
Diabetes mellitus	18 (24.0%)	20 (26.7%)
Hypertension	22 (29.3%)	24 (32.0%)
Smokers	16 (21.3%)	18 (24.0%)
Hemoglobin (g/dL)	13.1 ± 1.2	13.0 ± 1.3
INR	1.07 ± 0.11	1.08 ± 0.12
Creatinine (mg/dL)	0.98 ± 0.21	1.01 ± 0.24

For the primary outcome, secured hemostasis within five minutes was achieved in 72 (96.0%) patients in the electrocoagulation group compared to 61 (81.3%) in the adrenaline gauze group, while

unsecured bleeding occurred in 3 (4.0%) and 14 (18.7%) patients, respectively.

Table 2. Primary Outcome – Hemostatic Efficacy

Outcome	Electrocoagulation	Adrenaline Gauze	p-value
Secured hemostasis	72 (96.0%)	61 (81.3%)	0.006*
Unsecured bleeding	3 (4.0%)	14 (18.7%)	—

* statistically significant

The mean time to hemostasis was shorter (3.1 ± 1.2 vs. 5.4 ± 1.8 minutes), intraoperative blood loss was lower (58 ± 22 vs. 98 ± 35 mL), and operative time was reduced (46.2 ± 8.5 vs. 54.7 ± 11.2 minutes), all with p < 0.001. Additionally, hemostatic measures were required less

frequently in the electrocoagulation group (4.0% vs. 18.7%; p = 0.004). Conversion to open surgery was uncommon and comparable between groups (1.3% vs. 5.3%; p = 0.18). Although postoperative bleeding was lower in the electrocoagulation group (2.7% vs. 9.3%), the difference was

not statistically significant ($p = 0.08$). Patients treated with electrocoagulation reported significantly lower pain scores at 24 hours (3.2 ± 1.1 vs. 5.0 ± 1.5 ; $p < 0.001$), required fewer drains (10.7% vs. 22.7%; $p = 0.04$), and had shorter hospital stays (1.6 ± 0.7 vs. 2.8 ± 1.4 days; $p < 0.001$).

Overall surgical success analysis showed that 72 (96.0%) patients in the electrocoagulation group achieved successful outcomes, compared with 61 (81.3%) in the adrenaline gauze group, corresponding to a relative risk of 1.18 and a statistically significant difference ($p = 0.006$). Failures were more frequent in the adrenaline group (18.7% vs. 4.0%).

Table 3. Intraoperative Hemostasis Parameters

Variable	Electrocoagulation	Adrenaline Gauze	p-value
Time to hemostasis (min)	3.1 ± 1.2	5.4 ± 1.8	<0.001*
Blood loss (mL)	58 ± 22	98 ± 35	<0.001*
Operative time (min)	46.2 ± 8.5	54.7 ± 11.2	<0.001*
Additional measures required	3 (4.0%)	14 (18.7%)	0.004*
Conversion to open surgery	1 (1.3%)	4 (5.3%)	0.18

Table 4. Postoperative Outcomes

Variable	Electrocoagulation	Adrenaline Gauze	p-value
Postoperative bleeding	2 (2.7%)	7 (9.3%)	0.08
Pain score (VAS 24h)	3.2 ± 1.1	5.0 ± 1.5	<0.001*
Drain placement	8 (10.7%)	17 (22.7%)	0.04*
Length of stay (days)	1.6 ± 0.7	2.8 ± 1.4	<0.001*

Table 5. Overall Surgical Success

Variable	Electrocoagulation	Adrenaline Gauze	Relative Risk	p-value
Successful outcome	72 (96.0%)	61 (81.3%)	1.18	0.006*
Failed outcome	3 (4.0%)	14 (18.7%)	—	—

Discussion

This randomized controlled trial compared electrocoagulation and direct pressure applications with adrenaline-soaked gauze for liver bed hemostasis during laparoscopic cholecystectomy. The results indicate that electrocoagulation has a much better hemostatic effect, quicker control of bleeding, lower intraoperative blood loss, and a shorter operation time than adrenaline-soaked gauze. The findings imply that electrocoagulation is statistically and clinically superior to normal hemostasis on the liver bed. There was no significant difference in baseline demographic and clinical variables between groups, which demonstrated successful randomization and reduced bias from confounding factors. There were no significant differences in age, gender distribution, body mass index, or comorbidities such as diabetes and hypertension, which supports the idea that the changes in outcomes were attributable to the hemostatic technique rather than to patient-specific characteristics (14).

The most important result was that secured hemostasis was observed in 96 percent of patients treated with electrocoagulation, compared with 81.3 percent in the adrenaline gauze group. This significant difference indicates the high reliability of electrocoagulation in controlling bleeding in the highly vascular gallbladder bed. This benefit is probably due to the rapid coagulation of small vessels and the instant sealing of tissues. Conversely, direct pressure with adrenaline relies solely on temporary tamponade and vasoconstriction, which cannot maintain haemostasis in cases of persistent oozing or low-grade arterial bleeding, resulting in delayed or incomplete haemostasis (15). Electrocoagulation was also linked, in the short term, to homeostasis and a significant reduction in blood loss. Rapid control of bleeding enhances the visualization of the Calot triangle and the liver bed, resulting in safer and more efficient dissection. Less blood loss not only provides a better view of the operative field but also reduces postoperative morbidity. Likewise, the duration of the operation was shorter in the electrocoagulation group, probably because of fewer disruptions for adding more gauze and less need for a rescue homeostatic procedure (16).

The need for further interventions such as clips, sutures, or topical agents was significantly high in the group of patients that received adrenaline-soaked gauze. This observation indicates that gauze pressure is easy and low-cost, but it may not always achieve a conclusive homeostatic response. Additional methods can lengthen and complicate the surgical

procedure (12). Although the numerical differences in conversion to open surgery and postoperative bleeding complications were greater in the adrenaline group, these differences may have been due to the relatively small sample size and were not statistically significant. Electrocoagulation was also preferred by postoperative recovery parameters. Patients in this category had lower pain scores and shorter hospital stays (17). Such improvements could be attributed to less tissue handling, reduced number of repeat compressions, and reduced operative time. The practical benefits of reduced hospital occupancy include improved patient comfort, increased bed capacity, and lower overall healthcare costs (2,3). The study has several limitations that should be considered when interpreting its results. To begin with, it was conducted at a single tertiary care facility, which may limit the generalizability of the study to other facilities with varying levels of surgical expertise, patient volumes, or resources. Second, randomization was conducted, but the sample size was relatively small, which could have limited the ability to detect significant differences in less common events, such as postoperative hemorrhage and the need for open surgery. It was impossible to blind the operating surgeon because the nature of the interventions introduced an element of performance bias. Differences in surgical technique, although reduced by referring surgeries to experienced consultants, could also have affected surgical outcomes.

Conclusion

It is concluded that electrocoagulation provides significantly more effective and rapid hemostasis from the liver bed during laparoscopic cholecystectomy compared with direct pressure application using adrenaline-soaked gauze. Electrocoagulation was associated with higher rates of secured bleeding control, reduced intraoperative blood loss, shorter operative time, and improved postoperative recovery. Although adrenaline-soaked gauze remains a simple and inexpensive alternative, electrocoagulation demonstrated superior reliability and overall surgical efficiency. Therefore, electrocoagulation may be considered the preferred method for routine liver bed hemostasis during laparoscopic cholecystectomy.

Declarations

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-NHLHR-230/24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution**MS (Resident)**

Manuscript drafting, Study Design

MA (Professor)

Review of Literature, Data entry, Data analysis, and drafting articles.

FS (Associate Professor)

Concept of Study, Study Design, Review of Literature

BL (Resident)

Data Analysis, Manuscript drafting

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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