

COMPARISON BETWEEN METAL CLIP APPLICATION AND SUTURE LIGATION OF CYSTIC DUCT IN LAPAROSCOPIC CHOLECYSTECTOMY

Dr. Usman Akram^{*1}, Dr. Muhammad Kareem Ullah²^{*1}Post Graduate Trainee (FCPS General Surgery), Lahore General Hospital, Lahore.²Associate Professor / HOD General Surgery Department (Study Supervisor), Lahore General Hospital, Lahore.DOI: <https://doi.org/10.5281/zenodo.19466795>**Keywords**

Laparoscopic, Cholecystectomy, Cystic Duct, Metal Clip, Suture Ligation, Bile Leak, Operative Time.

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Corresponding Author: *

Dr. Usman Akram

Abstract

Background: Acute cholecystitis frequently requires laparoscopic cholecystectomy. Metal clips reduce operative time but may increase risks of bile leak or clip migration, whereas suture ligation offers greater safety. Conflicting evidence necessitated this comparative study.

Objective: To compare metal clip application and suture ligation of cystic duct in laparoscopic cholecystectomy in terms of frequency of bile leak and mean operation time.

Duration: Three months w.e.f. 03-04-2025 to 03-07-2025

Methodology: After ethical approval, 120 patients undergoing laparoscopic cholecystectomy for acute cholecystitis were enrolled and randomly assigned to metal clip or suture ligation groups. Standard four-port LC was performed under general anaesthesia, with cystic duct and artery secured by clips or chromic catgut ligatures. Procedures were conducted by a single consultant to ensure consistency and minimize bias.

Results: A total of 120 patients were included, with a mean age of 46.04 ± 11.30 years; 65% were above 40 years. Females comprised 60.8%, and the mean BMI was 27.52 ± 3.47 kg/m², with 75.8% overweight or obese. Operative time was 48.28 ± 8.35 min (metal clips) and 54.53 ± 9.65 min (suture ligation, $p=0.000$). Bile leak occurred in 6 patients (10.0%) with metal clips and none with suture ligation ($p=0.027$). Clip migration was 1.7% and 0% respectively ($p=1.000$).

Conclusion: The study concludes that suture ligation of the cystic duct reduces bile leak and clip migration, while metal clip application shortens operative time. Overall, suture ligation is recommended as the safer technique in laparoscopic cholecystectomy.

INTRODUCTION

Acute cholecystitis (AC) develops when the cystic duct becomes obstructed by a gallstone, leading to gallbladder distension and chemical or bacterial inflammation.¹ Gallstones are among the most common gastrointestinal disorders, affecting approximately 10% of the Western population, with over 80% of affected individuals remaining asymptomatic.^{1,2} Symptomatic gallstones progress to AC in 1–3% of cases. In Pakistan, the prevalence of gallstones has been reported to be around

10%.³ Laparoscopic cholecystectomy (LC) is the standard surgical treatment for AC and can typically be completed within 50 minutes when intraperitoneal conditions are favorable.^{4,5} LC is associated with improved patient comfort and faster recovery, consistent with enhanced recovery after surgery protocols. Bile leak is a notable postoperative complication, with an incidence of 1.4%, rising to 7% in complex cases.⁵ The cystic duct stump is the most frequent source of bile leak, often due to inadequate closure. Various

techniques exist to secure the cystic duct, but no definitive evidence establishes the optimal method for preventing bile leak.⁶

Chowdhury et al. in Bangladesh reported significantly higher frequency of bile leak in metal clip group than suture ligation group (10.0% vs. 0.0%; p-value=0.040).⁶ Naikoo et al. in India also reported higher frequency of bile leak in metal clip group than suture ligation group but here the difference was not significant (2.0% vs. 0.0%; p-value >0.05).⁷ Mohamed et al. also reported insignificantly higher frequency of bile leak in metal clip group than suture ligation group (6.7% vs. 0.0%; p-value=0.150).⁸

As regards, operation time, Mohamed et al. in Egypt reported significantly less operation time in metal clip group than suture ligation group (50.87±4.77 vs. 55.73±4.09 min; p-value=0.141).⁸ Ismaeil et al. in Iraq reported less operation time in clip group than suture ligation group (36.61±11.85 vs. 40.16±9.74 min; p-value=0.08) but the difference was not significant.⁹

Existing literature⁶⁻⁹ contained controversy and was not conclusive regarding bile leak and operation time with metal clip application and suture ligation of cystic duct in laparoscopic cholecystectomy. Due to above disagreement, it was imperative to conduct a study in local settings so as to create more conclusive evidence regarding supremacy of any of the two techniques over the other in terms of frequency of bile leak and operation time. Results of the study will be helpful in choosing more appropriate technique for handling cystic duct, in future practice of laparoscopic cholecystectomy.

METHODOLOGY

The study was a randomized controlled trial conducted in the Department of General Surgery, Lahore General Hospital, Lahore. The duration of the study was three months after the approval of the synopsis. A total of 120 patients (60 cases in each group) were included, calculated using the WHO calculator with 80% power of the test and 5% level of significance, taking the expected frequency of bile leak to be 10.0% versus 0.0% between metal clip and suture ligation groups, respectively.⁶ Non-probability consecutive sampling was used to select patients.

Patients of both genders aged above 18 years undergoing laparoscopic cholecystectomy for acute cholecystitis, as per the operational definition, and classified as ASA I or II, were included. Patients diagnosed with Mirizzi syndrome, those who required conversion to open surgery, or who presented with concomitant common bile duct stones were excluded. Acute cholecystitis was defined as patients with sonographic Murphy sign, peri-cholecystic fluid, gallbladder wall thickening ≥5 mm, or leukocytosis >10,000/μL. Laparoscopic cholecystectomy was performed in the reverse Trendelenburg position under general anesthesia with conventional four ports at least 5 cm apart in patients presenting with pain ≥3 on the VAS score and right hypochondrium pain for ≥6 weeks along with ultrasound evidence of acute cholecystitis. Bile leak was defined as bile in drain fluid (>3× serum bilirubin), imaging evidence, or aspirated abdominal fluid with elevated bilirubin. Mean operation time was recorded from the insertion of the first port until the extraction of the last port.

After approval from the Hospital's Ethical Review Board, patients were included after obtaining informed written consent. Their demographics were recorded. Patients were then randomly divided into two groups using the lottery method: Group A (Metal Clip Group, n=60) and Group B (Suture Ligation Group, n=60). The standard technique of laparoscopic cholecystectomy was performed in the reverse Trendelenburg position under general anesthesia using conventional four ports at least 5 cm apart. Special attention was given to adequate insulation of CO₂, proper lighting, and use of cauterization after holding tissue under complete visualization.

In Group A, dissection was performed at Calot's triangle. Three clips were applied to the cystic duct and one to the cystic artery, and both were transected. In Group B, the cystic duct was tied with a 10 cm long piece of chromic catgut No.1 using a double square knot, followed by a third single square knot on top. The excess thread was excised, and another ligature was applied near the neck of the gallbladder. The cystic duct was transected between these ligatures. All procedures were performed by a single senior consultant, and all findings were recorded by a resident to avoid

bias. Confounding variables were controlled through exclusion.

All collected data were entered and analyzed using SPSS version 26. Numerical variables, including age, BMI, and operation time, were presented as mean $\pm$ SD. Categorical variables, including gender, bile leak, and clip migration, were presented as frequency and percentage. Frequency of bile leak between the groups was compared using the chi-square test, with $p \leq 0.05$ considered significant. Mean operative time was compared using an independent sample t-test. Frequency of bile leak and mean operation time were stratified for age, gender, ASA and BMI to address effect modifiers. Post-stratification, chi-square tests were applied, taking $p \leq 0.05$ as significant.

RESULTS

A total of 120 patients were included in the study. The mean age was 46.04 ± 11.30 years, with 65.0% of patients aged above 40 years and 35.0% between 19–40 years. Females constituted the majority (60.8%), while 39.2% were males. The mean BMI was 27.52 ± 3.47 kg/m², and most patients were overweight or obese (75.8%), whereas 24.2% had normal body weight. Regarding preoperative physical status, 55.8% of patients were classified as ASA-I and 44.2% as ASA-II. Data is given in Table 1.0.

The baseline characteristics, including age, gender, BMI, and ASA status, were comparable between Group A and Group B, with no statistically significant differences ($p > 0.05$). Data is presented in Table 2.0.

The comparison of study outcomes between the two groups revealed notable differences. The mean operative time was significantly shorter in the metal clip group (Group A: 48.28 ± 8.35 min) compared to the suture ligation group (Group B: 54.53 ± 9.65 min, $p = 0.000$), reflecting the time-saving advantage of clip application. In terms of safety, bile leak occurred in 6 patients (10.0%) in Group A, whereas no cases were observed in Group B ($p = 0.027$), indicating a lower risk of this complication with suture ligation. Clip migration was rare, with only 1 patient (1.7%) affected in Group A and none in Group B ($p = 1.000$). These results suggest that while metal clips reduce operative time, suture ligation may offer superior safety in preventing bile leak. Data is presented in Table 3.0.

Stratified analysis showed that Group A consistently had shorter operative times, while Group B maintained lower rates of bile leak and clip migration across all subgroups. However, statistical significance was not achieved within the subgroups due to the small number of events.

Table 1.0: Demographic Characteristics of Patients Included in the Study

Characteristics	Total (120)
Age (years)	46.04 ± 11.30
• 19-40 years	42 (35.0%)
• > 40 years	78 (65.0%)
Gender	
• Male	47 (39.2%)
• Female	73 (60.8%)
BMI (kg/m ²)	27.52 ± 3.47
• Normal Weight	29 (24.2%)
• Overweight/Obese	91 (75.8%)
ASA Status	
• ASA-I	67 (55.8%)
• ASA-II	53 (44.2%)

Table 2.0: Comparison of Baseline Characteristics between the Study Groups

Characteristics	Group A (n=60)	Group B (n=60)	p-value
Age (years)	46.73±11.90	45.35±10.74	0.505
• 19-40 years	20 (33.3%)	22 (36.7%)	0.702
• > 40 years	40 (66.7%)	38 (63.3%)	
Gender			
• Male	22 (36.7%)	25 (41.7%)	0.575
• Female	38 (63.3%)	35 (58.3%)	
BMI (kg/m ²)	27.43±3.46	27.61±3.50	0.783
• Normal Weight	16 (26.7%)	13 (21.7%)	0.522
• Overweight/Obese	44 (73.3%)	47 (78.3%)	
ASA Status			
• ASA-I	32 (53.3%)	35 (58.3%)	0.581
• ASA-II	28 (46.7%)	25 (41.7%)	

Chi Square test/ Independent sample t test, taking p-value≤0.05 as significant.

Table 3.0: Comparison of Study Outcomes between the Groups

Characteristics	Group A (n=60)	Group B (n=60)	p-value
Operation Time (min)	48.28±8.35	54.53±9.65	0.000
Bile Leakage			
• Yes	6 (10.0%)	0 (0.0%)	0.027
• No	54 (90.0%)	60 (100.0%)	
Clip Migration			
• Yes	1 (1.7%)	0 (0.0%)	1.000
• No	59 (98.3%)	60 (100.0%)	

Independent sample t test/ Chi Square test/Fisher's Exact test, taking p-value≤0.05 as significant.

DISCUSSION

Acute cholecystitis is a common complication of gallstones, often requiring laparoscopic cholecystectomy for definitive treatment.¹⁰ Traditionally, the cystic duct has been secured using metal clips, which are quick and technically simple, but may carry a risk of bile leak and clip migration.^{11,12} Suture ligation has emerged as an alternative, potentially reducing these complications, though it requires longer operative time and greater technical skill.^{13,14} Existing literature presents conflicting evidence, with some studies reporting higher bile leak rates with clips, while others found no significant differences.^{6,9} Due to this controversy, the present study was planned to compare metal clip application and suture ligation in terms of operative time, bile leak, and clip migration.

Evidence from existing literature reveals diverse findings regarding the relative advantages of these two techniques. Chowdhury et al. reported a significantly higher incidence of bile leak in patients receiving metal clips (10.0%) compared to those undergoing suture ligation (0.0%, $p=0.040$), suggesting that suture ligation may provide superior safety in preventing this complication.⁶ Similarly, Riaz et al. observed that bile leakage occurred exclusively in the metal clip group, affecting 4 patients (3.3%), and concluded that intracorporeal suture ligation is safe and capable of managing all types of cystic ducts, despite a slightly longer operative time (metal clips: 2.53 ± 0.5 minutes vs. ligation: 4.79 ± 1.5 minutes).¹⁵ Several studies have further highlighted the practical benefits of suture ligation in specific contexts. Sankar et al. emphasized its utility in

primitive or peripheral surgical setups and in cases of instrument failure, noting that it can be safely performed without increasing patient morbidity.¹⁶ Teja et al. compared extracorporeal knotting with clip application and found that intraoperative complications occurred in 11 patients in the control group using clips, while none occurred in the suture ligation group; however, the mean operative time was slightly longer in the suture group (67.37 minutes) than the clip group (61.83 minutes).¹⁷

Other studies provide nuanced insights regarding operative efficiency and complication rates. Naikoo et al. reported a mean operative time of 41.2 minutes for clipping versus 46.8 minutes for suture ligation, with only one postoperative bile leak in the clipping group and one case of clip migration among 50 patients.⁷ Dubey et al. also found that clip application required a shorter mean ligation time (1.63 minutes) compared to suture ligation (2.5 minutes), with slightly higher but statistically insignificant bile spillage; importantly, no bile leak, clip migration, or CBD injury was observed, and suture ligation proved more cost-effective.¹⁸

Other studies corroborate these findings. Chidambaram et al. demonstrated that clip application significantly reduced cystic duct ligation time (8.67 ± 2.87 minutes) compared to suture ligation (12.30 ± 4.36 minutes, $p < 0.001$), while postoperative outcomes, including complications and hospital stay, were similar between the groups.¹⁹ Mohamed et al. reported mean operative times of 50.87 minutes for metal clips and 55.73 minutes for suture ligation, with the difference statistically insignificant ($p = 0.141$), concluding that suture ligation is a safe, effective, and cost-efficient alternative, especially when clip applicators fail.²⁰ Ismaiel et al. observed no significant differences in operative time or postoperative complications between the two techniques, supporting the safety of both methods.⁹

Finally, Rajra et al. reinforced the cost-effectiveness and safety of suture ligation, demonstrating that knot or ligature techniques can be a reliable alternative to metal clips, particularly in resource-limited settings.²¹ Overall, comparison of existing literature highlights a recurring pattern: metal clips offer shorter operative times, while suture ligation reduces the risk of bile leak and clip-related

complications. Despite minor variations in operative times and technical challenges, suture ligation consistently demonstrates safety and effectiveness, supporting its use as a preferred technique in specific clinical scenarios.

CONCLUSION

The study concludes that suture ligation of the cystic duct is associated with a lower risk of bile leak and clip migration, while metal clip application provides a shorter operative time. Considering both safety and efficacy, suture ligation is recommended as the preferred technique in laparoscopic cholecystectomy.

LIMITATIONS & RECOMMENDATIONS

This study's strengths include a randomized design, standardized operative techniques, and objective outcome measures such as operative time, bile leak, and clip migration, ensuring reliable comparison between metal clip application and suture ligation. Limitations include a single-center setting, relatively small sample size, and low frequency of adverse events, which limited subgroup analysis. Future studies should involve larger, multicenter trials, evaluate long-term outcomes, and consider cost-effectiveness to establish definitive recommendations for cystic duct management in laparoscopic cholecystectomy.

Authors Contribution

Author 1

Substantial contributions to study design, acquisition of data

Analysis & Interpretation of Data, Manuscript writing

Has given final approval of the version to be published

Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Author 2

Substantial contributions to concept, study design

Data Analysis, Manuscript writing, Critical Review

Has given final approval of the version to be published

Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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