



A Prospective Comparative Study of Metallic Clipping Versus Extracorporeal Knotting for Cystic Duct Ligation in Laparoscopic Cholecystectomy

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Abstract

Background: Secure cystic duct ligation is a critical step in laparoscopic cholecystectomy to prevent postoperative bile leakage and related complications. Metallic clips are commonly used because of their ease of application; however, clip slippage and migration remain concerns. Extracorporeal knotting using absorbable sutures has emerged as a cost-effective alternative.

Aim and Objectives of Study: To compare metallic clipping versus extracorporeal knotting for cystic duct ligation during laparoscopic cholecystectomy in terms of operative safety, intraoperative complications, operative time, and cost-effectiveness.

Materials and Methods: This prospective comparative observational study was conducted at Gadag Institute of Medical Sciences, Karnataka, from July 2022 to July 2024. Sixty patients undergoing laparoscopic cholecystectomy were included and divided into two groups of 30 patients each. In one group, cystic duct ligation was performed using extracorporeal knotting with absorbable suture material, while metallic clips were used in the other group. Operative time, intraoperative complications, postoperative pain, and procedural cost were analyzed.

Results: The mean operative time was 67.37 ± 15.23 minutes in the extracorporeal knotting group and 61.83 ± 10.55 minutes in the metallic clip group, with no statistically significant difference ($p = 0.107$). No intraoperative complications were noted in the extracorporeal knotting group. In the metallic clip group, complications included clip slippage with stone spillage in 23.3% of patients, clip slippage with bile leak in 10%, and clip migration in 3.3% of patients ($p = 0.0037$). The mean cost of suture material in the extracorporeal knotting group was significantly lower compared to metallic clips.

Conclusion: Extracorporeal knotting is a safe and cost-effective alternative to metallic clipping for cystic duct ligation during laparoscopic cholecystectomy. Although the operative time was slightly longer, the technique demonstrated fewer intraoperative complications and lower procedural cost.

Keywords: Laparoscopic cholecystectomy, cystic duct ligation, extracorporeal knotting, metallic clips, bile leak, cost-effectiveness

Introduction

Laparoscopic cholecystectomy is the gold standard procedure for the management of symptomatic gallstone disease because of its advantages

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of reduced postoperative pain, shorter hospital stay, faster recovery, and improved cosmetic outcomes compared with open cholecystectomy. Secure ligation of the cystic duct is a critical step during the procedure to prevent bile leakage and associated complications such as biliary peritonitis, intra-abdominal abscess, and biliary fistula. Metallic clips are widely used for cystic duct ligation because they are easy to apply and reduce operative duration. However, complications such as clip slippage, migration, bile leak, and difficulty in securing wide cystic ducts have been reported. In resource-limited settings, the cost of metallic clips may also become a significant concern.

Extracorporeal knotting with absorbable suture material is an alternative technique that avoids permanent foreign material and may provide secure duct closure with reduced procedural cost. Previous studies have demonstrated that extracorporeal knotting is safe and effective, although it may require greater technical expertise and slightly longer operative time. The present study was conducted to compare metallic clipping and extracorporeal knotting for cystic duct ligation in laparoscopic cholecystectomy with respect to operative safety, intraoperative complications, operative duration, postoperative pain, and cost-effectiveness.

Aim and Objectives of Study

The primary objective of this study is to compare metallic clipping and extracorporeal knotting for cystic duct ligation in laparoscopic cholecystectomy. Specifically, the study aims to:

1. To compare intraoperative complications between the two techniques and assess their safety with respect to the common bile duct.
2. To compare operative duration.
3. To assess cost-effectiveness.
4. To evaluate postoperative outcomes.

Material and Methods

This prospective comparative observational study was conducted in the Department of General Surgery, Gadag Institute of Medical Sciences, Karnataka, from July 2022 to July 2024 after obtaining approval from the Institutional Ethics Committee. Sixty consecutive patients diagnosed with symptomatic cholelithiasis or cholecystitis and scheduled for elective laparoscopic cholecystectomy were included after obtaining written informed consent. Patients fulfilling the inclusion criteria were allocated into two groups comprising 30 patients each. Group A underwent cystic duct ligation using extracorporeal knotting with absorbable suture material, while Group B underwent cystic duct ligation using standard metallic clips. All procedures were performed using the standard four-port laparoscopic technique. After achieving

the critical view of safety, the cystic artery was divided and the cystic duct was ligated according to the allocated technique.

In the extracorporeal knotting group, the cystic duct was ligated using an absorbable polyglactin 910 (Vicryl® 2-0) suture. A modified Roeder knot incorporating the Meltzer modification (2:3:2 configuration) was fashioned extracorporeally and advanced into the peritoneal cavity using a knot pusher to securely ligate the cystic duct before division. The knotting technique was standardized and applied uniformly across all procedures in the extracorporeal knotting group. In the metallic clip group, titanium clips (LT300) were applied across the cystic duct according to standard surgical practice prior to division. All procedures were performed by the same consultant surgeon to minimize operator-related bias. Operative time, intraoperative complications, postoperative pain, and cost of ligation material were recorded. Patients were followed for two months to assess postoperative complications.

Sample Size and Sampling Method

Based on a study done by Sharad kumar et al in 2020, the anticipated mean $\pm$ SD of operating time by Extracorporeal knotting vs using clips was 60.50 ± 14.93 and 47.83 ± 14.77 respectively. The minimum sample size is 30 per group with 95% level of significance and 80% power.

$$N = 2 \left[\frac{(Z_{1-\alpha/2} + Z_{\beta}) * S}{d} \right]^2$$

$Z_{1-\alpha/2}$ - Level of significance = 95%

Z_{β} - power of the study = 80%

d – clinically significant difference between two parameters

SD - Common standard deviation

The sample size is determined based on previous studies and statistical calculations, aiming for 30 patients in each group (metallic clipping and extracorporeal knotting). This sample size is calculated to provide adequate power (80%) and significance (95%) to detect clinically meaningful differences between the two groups. Purposive sampling was used to select participants who meet the inclusion criteria.

Inclusion Criteria

1. Patients diagnosed with calculous or acalculous cholecystitis.
2. Patients willing to participate in the study.

Exclusion Criteria

1. Patients unfit for general anaesthesia.
2. Patients with common bile duct stones.

3. Patients undergoing conversion to open cholecystectomy.

Written informed consent was obtained from all participants. Detailed clinical evaluation and routine investigations were performed preoperatively.

Parameters analyzed included:

- Operative time
- Intraoperative complications
- Post operative pain
- Cost of ligation material

Patients were followed up postoperatively and reviewed after two months.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics (Version 31.0.2.0, IBM Corp, Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation and compared using the independent Student's t-test or Mann-Whitney U test where appropriate. Categorical variables were analysed using the Chi-square test or Fisher's exact test whenever indicated. A two-tailed p value of <0.05 was considered statistically significant.

Results

A total of 60 patients were included in the study, with 30 patients in each group over a period of 24 months, from June 2022 to July 2024.

Table 1: Comparison of Age (Years) between Study and Control groups

Age (Years)	Mean	± S.D.	Mann Whitney U test	P value	Remarks
Study	40.83	10.161	U=386.000	P = 0.3477	NS
Control	39.366	5.89			
NS: No significant					

The mean age in the extracorporeal knotting group was 40.83 ± 10.16 years, while the mean age in the metallic clip group was 39.36 ± 5.89 years. Female patients predominated in both groups.

Table 2: Distribution of subjects according to Intra operative complication

Intra operative complications	Study group		Control group		Chi square test	Remark
	N	%	N	%		
BILE LEAK	0	0	0		X ² =13.469	P = 0.0037*
CLIP MIGRATION	0	0	1	3.3		
CLIP SLIPPAGE, BILE LEAK	0	0	3	10		
CLIP SLIPPAGE, STONE SPILLAGE	0	0	7	23.3		
NIL	30	100	19	63.3		
Total	30	100	30	100		
*: Highly significant						

No intraoperative complications were observed in the extracorporeal knotting group. In the metallic clip group, clip slippage with stone spillage occurred in 23.3% of patients, clip slippage with bile leak in 10%, and clip migration in 3.3% of patients. This difference was statistically significant ($p = 0.0037$).

Table 3: Comparison of Operation time (Minutes) between Study and Control groups

Operation time (Minutes).	Mean	± S. D	Difference in mean (%)	Unpaired t test	P value	Remarks
Study	67.37	15.23	4.68	t=1.636	P = 0.107	NS
Control	61.83	10.55	-6.94%			
NS: Not significant						

The mean operative time was slightly longer in the extracorporeal knotting group (67.37 ± 15.23 minutes) compared to the metallic clip group (61.83 ± 10.55 minutes), but the difference was not statistically significant ($p = 0.107$).

Table 4: Comparison of Cost of Suture/Clips (In Rupees) between Study and Control group

Cost of Suture/Clips (Rupees)	Mean	± S.D.	Difference in mean (%)	Mann Whitney U test	P value	Remarks
Study	302	0	198 (39.6%)	NA		
Control	500	0				
NA: Not applicable						

Statistical comparison was not performed because the cost was fixed within each group

The cost of ligation material was significantly lower in the extracorporeal knotting group compared with the metallic clip group. Postoperative pain scores were comparable between the two groups and did not show statistical significance

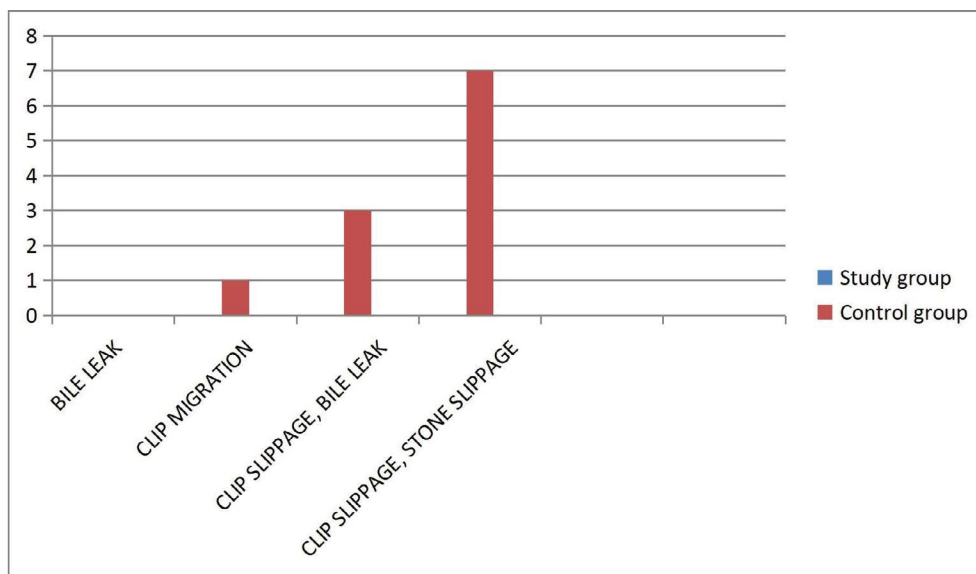


Figure 1: Distribution of Intraoperative complications in the two study groups

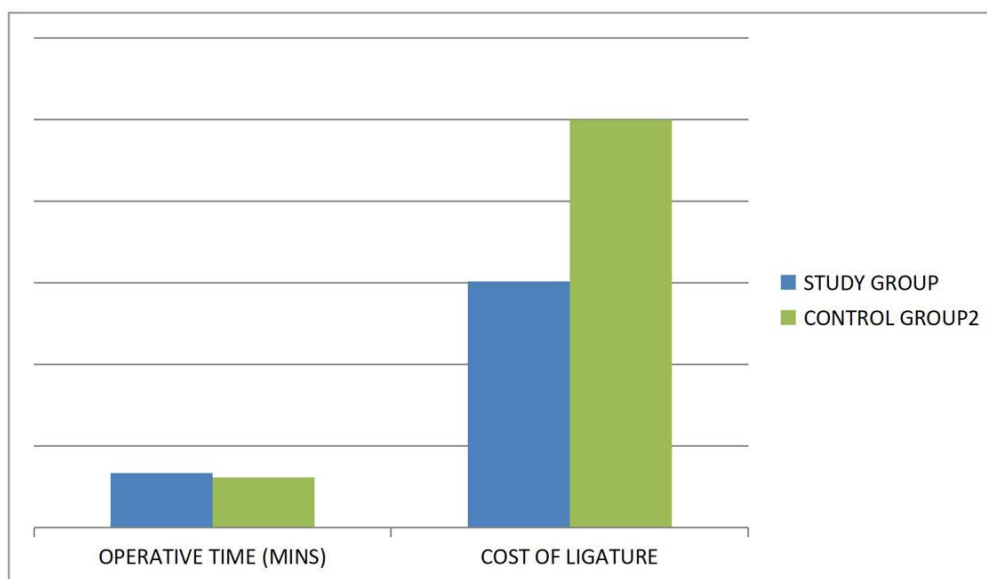


Figure 2: Comparison of Operation time, cost of suture, and post-operative pain

Followup

All patients were followed up for a period of 2 months, and no significant complications were noted.

Discussion

Secure cystic duct ligation is essential in laparoscopic cholecystectomy to prevent postoperative bile leakage and associated morbidity. Metallic clips are widely used because of their convenience and shorter application time. However, complications such as clip slippage and migration continue to be reported.

In the present study, no intraoperative complications were observed in the extracorporeal knotting group, whereas complications occurred in the metallic clip group, including clip slippage, bile leak, and clip migration. These findings support previous studies by Kuldeep Singh et al, And Sharad

Kumar et al, who reported extracorporeal knotting to be a safe and economical alternative. Although the operative time was marginally longer in the extracorporeal knotting group, the difference was not statistically significant. The slightly increased duration maybe attributed to the learning curve associated with knot preparation and placement.

The present findings support the use of extracorporeal knotting as a safe, reliable, and cost-effective alternative to metallic clips, particularly in resource-limited healthcare settings where reducing operative expenditure is an important consideration. Although the operative time was marginally longer, the difference was not statistically significant, and no increase in postoperative morbidity was observed.

Limitations

The present study has several limitations. It was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalisability of the findings. The follow-up period was limited to two months; therefore, late complications such as delayed clip migration or biliary stricture could not be evaluated. Larger multicentre randomised controlled trials with longer follow-up are required to confirm these findings.

Conclusion

Extracorporeal knotting is a feasible, safe, and cost-effective alternative to metallic clipping for cystic duct ligation during laparoscopic cholecystectomy. Although operative time was slightly longer, extracorporeal knotting demonstrated fewer intraoperative complications and lower procedural cost. The technique may be particularly beneficial in resource-limited surgical settings.

Declarations

Ethical Approval: Institutional Ethics Committee approval was obtained prior to commencement of the study.

Conflict of Interest: The authors declare no conflict of interest.

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