

## ORIGINAL ARTICLE

**SAFETY OF EXTRACORPOREAL KNOT LIGATION OF WIDE CYSTIC DUCT IN LAPAROSCOPIC CHOLECYSTECTOMY AT A THQ HOSPITAL**Sidra Dil Muhammad<sup>1</sup>, Muhammad Saad Faisal<sup>2</sup>, Nabila Salamat<sup>3</sup>, Muhammad Rizwan Saeed<sup>4</sup>**ABSTRACT**

**Introduction:** Laparoscopic cholecystectomy is the gold standard treatment of cholelithiasis and is a well-known procedure among patients globally because of less post-operative pain and early recovery. Wide cystic duct is one of the challenges which encountered in laparoscopic cholecystectomy and managing it laparoscopically demands expertise and gadgets. Although several studies are available in literature which compared outcomes of knot ligation versus clip ligation of cystic duct in laparoscopic cholecystectomy but, only few studies have discussed the wide cystic duct management and reported the outcomes of suture ligation of wide cystic duct.

**Material & Methods:** This retrospective study was conducted at Government THQ Hospital Sabzazar, Lahore from May 2021 to October 2023 and included 63 patients with wide cystic duct. Cystic duct was ligated by extracorporeal Roeder's knot in all cases. Patient's demographics and Outcome were recorded.

**Results:** Mean age of patients was  $41.30 \pm 3.92$  years. There were 12.69% males and 87.30% females with male to female ratio of 1:6.8. Mean BMI was  $32.98 \pm 4.01$  Kg/m<sup>2</sup>. Previous history of obstructive Jaundice and ERCP was found in 4.76% and 3.17% patients, respectively. There were 36.50% diabetic and (65.07%) hypertensive patients. Mean time taken for extracorporeal Roeder's knot formation and application was  $2.01 \pm 0.46$  min. Bile leak, retained cystic duct stone, sub-hepatic collection, postoperative jaundice and mortality were not observed in any patient.

**Conclusion:** Extracorporeal knot ligation of wide cystic duct with Vicryl 1 in laparoscopic cholecystectomy is safe.

**Key Words:** extracorporeal knot, laparoscopic cholecystectomy, wide cystic duct

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## INTRODUCTION

Laparoscopic cholecystectomy is the gold standard treatment of cholelithiasis and well know procedure among patients globally because of less post-operative pain and early recovery.<sup>1,2</sup> Safe and secure closure of cystic duct decreases the morbidity after laparoscopic cholecystectomy.<sup>3</sup> Incidence of bile leak after laparoscopic cholecystectomy is low i.e. less than 2%, and leading causes are iatrogenic bile duct injury or leak from gall bladder bed.<sup>4-6</sup>

During laparoscopic cholecystectomy, surgeon faces many technical difficulties including adhesion, frozen calot's triangle, thick-walled gall bladder, impacted neck stone and short cystic duct.<sup>7-9</sup> Wide cystic duct is one of the challenges which encountered in laparoscopic cholecystectomy and managing it laparoscopically demands expertise and gadgets e.g. polymer clips, expertise for intracorporeal or extracorporeal suture ligation of cystic duct.<sup>9,10</sup>

Although several studies are available in literature which compared outcomes of knot ligation versus clip ligation of cystic duct in laparoscopic cholecystectomy but, only few studies have discussed the wide cystic duct management and reported the outcomes of suture ligation of wide cystic duct.<sup>10-12</sup> In a prospective randomized study by Soomro AA<sup>13</sup> et al, bile leak was reported in 2.5% patients, underwent knot ligation of cystic duct in laparoscopic cholecystectomy. However, in a retrospective study by Mohamed M<sup>14</sup> et al, none of the patients was reported with bile leak after knot ligation of wide cystic duct. The aim of this study was to assess the safety of extracorporeal Roeder's knot ligation of wide cystic duct in laparoscopic cholecystectomy in terms of outcomes, performed by a single consultant surgeon at a THQ hospital Lahore.

## MATERIAL AND METHODS

This retrospective study was conducted at Government THQ Hospital Sabzazar, Lahore from May 2021 to October 2023. This study included 63 patients with wide cystic duct on laparoscopic cholecystectomy, of both gender, BMI  $\leq$  40 Kg/m<sup>2</sup>, between 18 to 80 years of age and gall bladder wall thickness on USG  $\leq$  3mm. Patient with ASA (American Society of Anesthesiologists) score III & IV, asthma, ischemic heart

disease, jaundice, bleeding disorders (Deranged coagulation profile), hepatitis C and choledocholithiasis on USG were excluded from the study. The study was approved by the Ethical Review committee as per institutional guidelines.

**Wide cystic duct:** Cystic duct was labelled wide if it's width was  $>0.5$ cm and  $<1.8$ cm, visualized by 30° telescope during laparoscopic cholecystectomy. Width of cystic duct (upper limit i.e.  $< 1.8$ cm) was measured during laparoscopic cholecystectomy by using jaw length (L=1.8cm) of curved Maryland forceps (Figure 1B, Figure 2B). Cystic duct that was enclosed within the jaws of curved Maryland forceps but appeared beyond the extent of Liga clip (LT 400) ligation (Figure 1A, Figure 2B), was labelled as wide cystic duct and selected for extracorporeal knotting. Figure 1A shows Length of LT400 Liga Clip and figure 1B shows Length of Curved Maryland jaw.

**Surgical technique:** All cholecystectomies were performed laparoscopically with four port technique by single consultant surgeon. Wide cystic duct (Figure 2A) was assessed by the length of jaws of curved Maryland forceps (Figure 2B) and ligated by single extracorporeal Roeder's knot with Vicryl 1 suture (Figure 2D, E & F). Vicryl 1 was used for extracorporeal knotting to avoid tissue cutting effect of Vicryl 2/0 at cystic duct. After achieving critical view of safety and before applying knot, stones were milked from cystic duct and attempted to lock in gall bladder with large clip (LT 400) by partially occluding the gall bladder lumen to avoid cystic duct stone later (Figure 2C). Vicryl 1 was introduced through epigastric port with the help of Maryland forceps, wrapped around the cystic duct and taken out of the epigastric port where Roeder's knot was made and secured around cystic duct with the help of knot pusher. Only single knot was applied to occlude cystic duct lumen. Cystic duct, near the gall bladder, was secured with Liga clips (LT 400) in a step ladder pattern (Figure 2E & F). Later, cystic duct was divided between knot and clips, and gall bladder was dissected off the liver. Rest of cholecystectomy was performed as per standard technique and subhepatic drain was placed in all cases. Outcomes in terms of bile leakage, retained cystic duct stone, subhepatic collection, postoperative jaundice, mortality and ERCP (endoscopic retrograde cholangiopancreatography) required after procedure or on follow up visits (4 weeks

postoperatively) were recorded.

All the collected data were entered into SPSS version 22 and analyzed. Quantitative data like age, BMI, time taken for extracorporeal knot, operative time, drain output, duration of drain and length of hospital stay were presented as means and standard deviations. The qualitative data like gender, DM, HTN, previous history of obstructive jaundice and ERCP, indication of surgery and outcome were presented as frequency and percentage.

**Figure 2:** A: Wide cystic duct, B: Width of cystic duct measured with jaws of curved Maryland Forceps (Cystic duct enclosed within jaws of Maryland Forceps), C: Large Liga clip is partially occluding the gall bladder lumen, applied after milking of cystic duct stones, D: Wide cystic duct ligated by single extracorporeal Roeder's knot, E & F: Closed cystic duct stump & step ladder pattern of Liga clips over gall bladder

## RESULTS

Mean age of the patients was  $41.30 \pm 3.92$  years (Range: 31-56 years). There were 8 (12.69%) males and 55 (87.30%) females with male to female ratio of 1:6.8. Mean BMI was  $32.98 \pm 4.01$  Kg/m<sup>2</sup>. Previous history of obstructive Jaundice and ERCP was found in 03 (4.76%) and 02 (3.17%) patients, respectively. There were 23 (36.50%) diabetics and 41 (65.07%) hypertensive patients. Ultrasonography showed impacted gall bladder neck stones in 9 (14.28%) patients, solitary gall bladder stones in 24 (40.0%) and multiple stones in 39 (65.0%) patients. Indication and outcomes of laparoscopic cholecystectomy are shown in table I.

## DISCUSSION

Laparoscopic cholecystectomy is a never-ending topic of discussion among general surgeons. Adopting the methodology of triangle of safety keeps surgeons out of danger zone of biliary injuries. However, triangle of safety is not the end point of safe cholecystectomy. As postoperative bile leak is an alarming situation, safe and secure ligation of cystic duct is also involved in accomplishment of safe cholecystectomy. Titanium clips, polymer clips, suture ligation and endo staplers are used to close cystic duct stumps of variable sizes. In our study, we dealt with wide cystic duct

laparoscopically by extracorporeal Roeder's knot ligation in 63 patients and reported its outcome.

Similar to a prospective randomized study by Soomro AA<sup>13</sup> et al, mean age of patients in our study was  $41.30 \pm 3.92$  years. However, younger patients (Mean: 31.3 years) were noted in a tertiary hospital based observational study by Naikoo GM<sup>9</sup> et al, and older age group i.e.  $45 \pm 17.2$  years, was observed in a retrospective study by Mohamed M<sup>14</sup> et al. In comparison to studies by Soomro AA<sup>13</sup> et al, and Mohamed M<sup>14</sup> et al, higher male to female ratio was noted in our study i.e. M:F; 1:2, 1:3 vs. 1:6, respectively. Majority of patients in our study were obese. The risk factors for cholelithiasis i.e. Fat, Female and Forty, are observed in our study. Comparable to a prospective randomized study by Soomro AA<sup>13</sup> et al, 3.17% Patients had preoperative ERCP in our study. Commonest indication of surgery was biliary colic (31.74%), followed by interval cholecystectomy (28.57%) in our study, however interval cholecystectomy (17.5%) was the leading indication for surgery in a study by Soomro AA<sup>13</sup> et al.

Mean operative time in our study is comparable to the operative time reported in a study by Soomro AA<sup>13</sup> et al, i.e.  $61.06 \pm 5.98$  vs. 61- 65 min. However, Mohamed M<sup>14</sup> et al, in a retrospective study and Teja HV<sup>12</sup> et al, in a case series, reported longer duration of surgeries i.e.  $69 \pm 13$  min. and  $67.37 \pm 15.23$  min, respectively. The reason for the shorter duration of surgery in our study was that the majority of cases were simple i.e. biliary colic and uncomplicated i.e. interval cholecystectomy. So, less time was consumed in dissection of calot's triangle and gall bladder. Similar to a retrospective study by Mohamed M<sup>14</sup> et al, shorter hospital stay was observed in our study i.e.  $2.58 \pm 1.01$  and 2-3 days, respectively. The reason for the shorter hospital stay was uncomplicated cholecystectomies. Mean time taken for extracorporeal Roeder's knot formation and application was  $2.01 \pm 0.46$  min. in our study. However, in a tertiary hospital based observational study by Naikoo GM<sup>9</sup> et al, longer duration i.e. 3.5min, was required for intracorporeal cystic duct ligation by either silk or vicryl 2/0 for elective cases. The reason for the shorter duration of knotting in our study was that the surgeon already had expertise of extracorporeal knot formation and application. Similar to a study by Mohamed M<sup>14</sup> et al, bile leak was not observed in any (0.0%) patient in

our study. However, Soomro AA<sup>13</sup> et al, reported bile leak in 2.5% after extracorporeal knot ligation of wide cystic duct with Vicryl 1. There are several possible reasons of zero postoperative bile leak in our study. Firstly, we strangulated cystic duct with Vicryl 1 to elude cheese wire cutting effect of thinner suture i.e. vicryl 2/0, over the cystic duct which could be one precaution to escape bile leak. Secondly, knot was tightened firmly over the cystic duct by pulling the untangled external end of suture extracorporeally while keeping the suture un-winded around knot pusher. Thirdly, in all cases, closed cystic duct stump was evaluated at the end of surgery by visualizing for any bile leak. Fourthly, width of cystic duct in our study was less (<1.8cm) as compared to the study by Soomro AA<sup>13</sup> et al, i.e. 2.2cm. Similar to our study, Mohamed M<sup>14</sup> et al didn't observed bile leak and the width of cystic duct selected for knot was lesser i.e.1.5cm, than width of cystic duct in our study. Sub-hepatic collection was not reported in any (0.0%) patient in our study. Similar to a study by Soomro AA<sup>13</sup> et al, postoperative jaundice and mortality were not witnessed in any (0.0%) patient in our study. Retained cystic duct stone was not detected in any (0.0%) patient in our study because cystic duct stones were milked and partially engaged in gall bladder body by applying large Liga clip before application of knot. This maneuver kept cystic duct free of stones while knot application. We utilized Vicryl 1 for cystic duct ligation, however Mohamed M<sup>14</sup> et al, used 2/0 vicryl for the same purpose. We secured gall bladder end with large Liga Clips in a step ladder pattern however, Soomro AA<sup>13</sup> et al, secured gall bladder end with knot.

Cystic duct width measurement and its secure ligation both are challenging aspects for beginners when encountered with wide cystic duct. Jaws of Maryland forceps can be taken as scale to measure the size of duct and expertise of extracorporeal knotting can serve in achieving the safe laparoscopic cholecystectomy. Fear of retained cystic duct stones can be minimized by large Liga clip application over gall bladder after sweeping cystic duct stones towards gall bladder body. It is a uni-center and single consultant study on limited population.

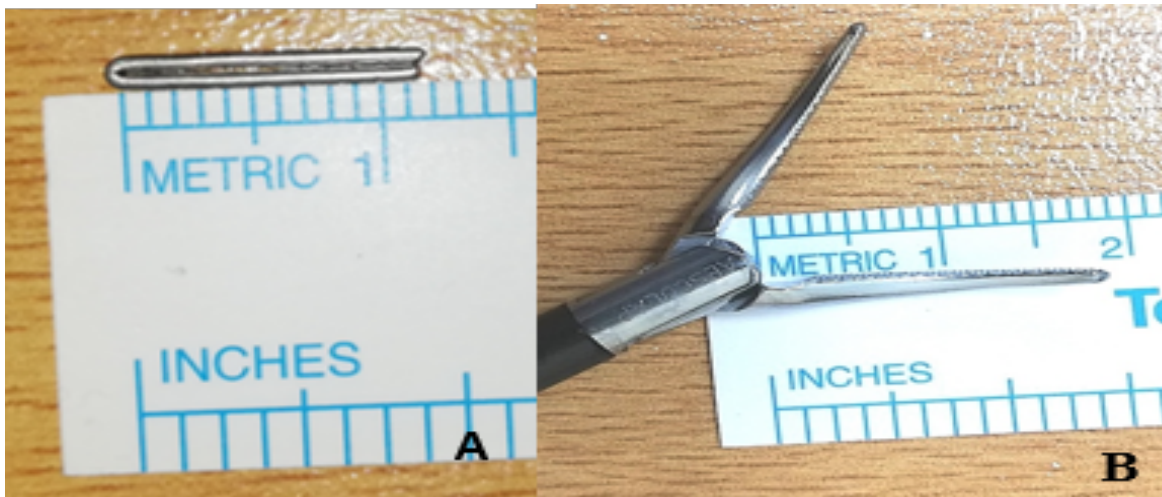
## CONCLUSION

It is concluded that the extracorporeal knot ligation of wide cystic duct with Vicryl 1 in laparoscopic cholecystectomy is safe if the cystic duct width is <1.8cm, stones kept held in gall bladder sack with Liga clip and expertise for knot formation & application are available.

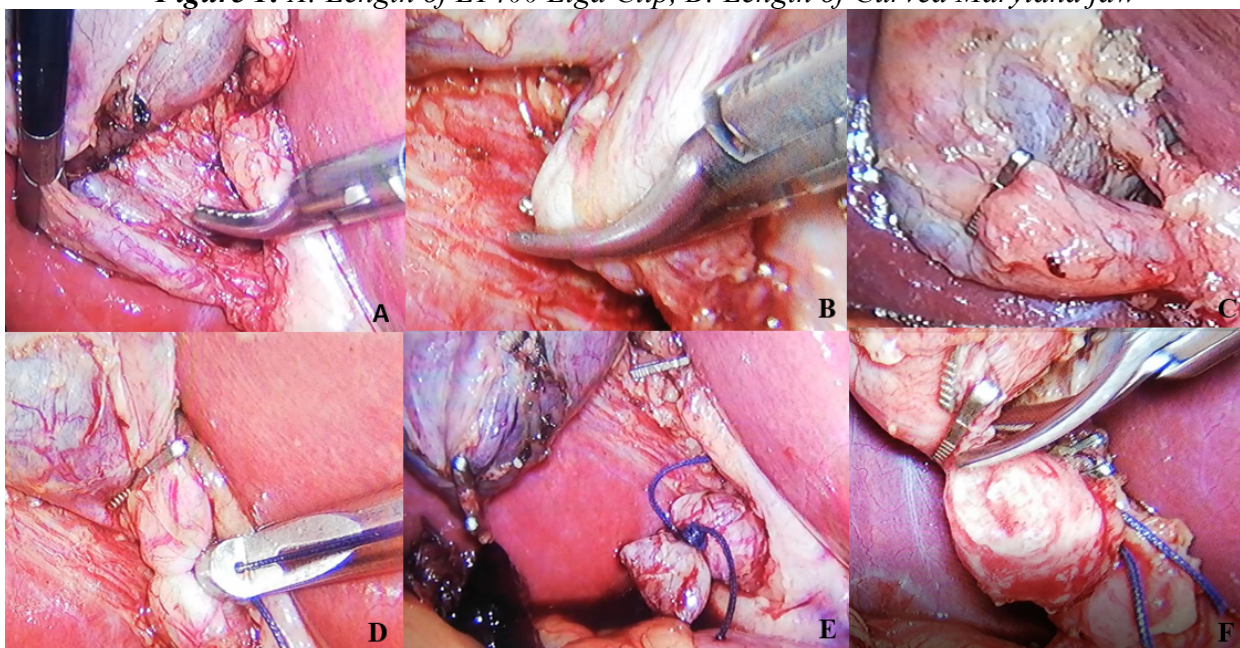
## REFERENCES

1. Mahadevan V. Anatomy of the gallbladder and bile ducts. *Surg.* 2020;38(8):432-6.
2. Ibrarullah M, Mohanty L, Mishra A, Panda A, Sikora SS. Anatomical appraisal of safe cholecystectomy: a prospective study. *ANZ J Surg.* 2023;93(5):1329-34.
3. Nassar AH, Ng HJ. Risk identification and technical modifications reduce the incidence of post-cholecystectomy bile leakage: analysis of 5675 laparoscopic cholecystectomies. *Langenbeck's Arch Surg.* 2022;407(1):213-23.
4. Muhammed BS. Management of cystic duct stone (s) during laparoscopic cholecystectomy. *Zanco J Med Sci.* 2022;26(2):185-93.
5. Ismaeil DA, Shkor FN, Salih AM, Ahmed MM, Said AH, Ali HO, Jalal HK. Tie versus clipping typed of cystic duct and artery ligation in laparoscopic cholecystectomy. *Bali Med J.* 2020;9(2):556-61.
6. Prabu KM, Balaji D, Pai VM. Is suture ligation of cystic duct in laparoscopic cholecystectomy a safe alternative to clipping? Our experience in a rural centre. *Int Surg J.* 2019;6(10):3715-8.
7. Arkle T, Lam S, Toogood G, Kumar B. How should we secure the cystic duct during laparoscopic cholecystectomy? A UK-wide survey of clinical practice and systematic review of the literature with meta-analysis. *Ann R Coll Surg Engl.* 2022;104(9):650-4.
8. Firat YD, Erol MF. Safe use of vascular stapling devices during laparoscopic cholecystectomy in cases with enlarged cystic canal. *Eur Res J.* 2020;6(5):479-84.
9. Naikoo GM, Rather M, Gilkar IA. Clipping Vs Suture ligation of cystic duct and artery in laparoscopic cholecystectomy: A tertiary care based observational study. *Int Surg J.* 2021;5(2):84-7.
10. Mohamed IA, Elewesey EA, Saad AS. A Comparative Study Between Cystic Duct Clipping and Ligation in Laparoscopic Cholecystectomy. *Al-Azhar Intern Med J.* 2023;4(3):6-9.
11. Donkervoort SC, Dijksman LM, van Dijk AH, Clous EA, Boermeester MA, van Ramshorst

- B, Boerma D. Bile leakage after loop closure vs clip closure of the cystic duct during laparoscopic cholecystectomy: A retrospective analysis of a prospective cohort. *World J Gastrointest Surg.* 2020;12(1):9-16.
12. Teja HV, Chavan DR, Kullolli G. A Comparative Study of Extracorporeal Knotting vs Clips for Ligating Cystic Duct in Laparoscopic Cholecystectomy. *World J Laparosc Surg.* 2022;15(1): 14-17.
13. Soomro AA, Morai SJ, Shakeel N, Memon J, Yuosif S, Gharno R. Ligature Technique: A Safe Outcome in Laparoscopic Cholecystectomy. *PJMHS.* 2022;6(1):1038-40.
14. Mohamed M, Ramadan A, Mansy W. How to manage a dilated cystic duct during laparoscopic cholecystectomy?. *Egypt J Surg.* 2020;39(4):1077-81.



**Figure 1:** A: Length of LT400 Liga Clip, B: Length of Curved Maryland jaw



**Figure 2:** A: Wide cystic duct, B: Width of cystic duct measured with jaws of curved Maryland Forceps (Cystic duct enclosed within jaws of Maryland Forceps), C: Large Liga clip is partially occluding the gall bladder lumen, applied after milking of cystic duct stones, D: Wide cystic duct ligated by single extracorporeal Roeder's knot, E & F: Closed cystic duct stump & step ladder pattern of Liga clips over gall bladder

*Table I: Indication and outcomes of laparoscopic cholecystectomy (n=63)*

<b>Variables</b>		<b>No. of patients (%)</b>
Indication of surgery	Biliary colic	20 (31.74%)
	Acute cholecystitis	11 (17.46%)
	Chronic cholecystitis	3 (4.76%)
	Mucocele	6 (9.52%)
	Empyema	2 (3.17%)
	Gall bladder polyp	3 (4.76%)
	Interval cholecystectomy	17 (26.98%)
	Biliary pancreatitis	1 (1.58%)
Mean operative time (min.)		61.06±5.98
Mean time taken for extracorporeal Roeder's knot formation and application (min.)		2.01±0.46
Mean hospital stay (days)		2.58± 1.01
Mean Drain output (ml)		28.09±11.47
Mean Duration of drain (days)		3.06±1.98
Outcome	Bile leakage	0 (0.0%)
	Retained cystic duct stone	0 (0.0%)
	Sub-hepatic collection	0 (0.0%)
	Postoperative jaundice	0 (0.0%)
	ERCP required	0 (0.0%)
	Mortality	0 (0.0%)