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Cystic Duct Stump Clearance with Distal Clipping and Proximal Sweeping (DCPS) Technique in Laparoscopic Cholecystectomy: A Cross-Sectional Study

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ABSTRACT

Background: After laparoscopic cholecystectomy (LC) for Cholelithiasis, persistence of the symptoms may occur in 5% of patients. The cystic duct remnant calculus can be one of the causes. Distal clipping and proximal sweeping (DCPS) are one of the methods to clear cystic duct. **Objective:** To determine the proportion of patients who achieve clearance of the cystic duct stump from stones or sludge using the Distal Clipping and Proximal Sweeping (DCPS) technique during LC. **Methods**: This cross-sectional study was conducted on patients undergoing LC by a consultant general surgeon or a registrar under supervision, in the Department of General Surgery at a tertiary care hospital in Karachi, Pakistan, from February to December 2023. The intra-operative DCPS technique involves achieving the critical view of safety, clipping the cystic duct at its junction with the Hartmann's pouch (distal clipping), making a small incision proximally towards the CBD, and gently sweeping the common bile duct (CBD) and cystic duct towards incision to clear any sludge or stones in the cystic duct stump. **Results:** A total of 174 Patients were enrolled in the study with the mean age of 47.11 ±14.37. There was a female predominance 103 (59.2%) and 99 patients had co-morbidities. Mean ± SD Duration of Surgery in all patients was 76.59 ±20.62 minutes from incision to dressing. DCPS was positive in 84 patients (48.2%) for stone/sludge; 26 (14.9%) for stones and 58 (33.3%) for sludge. None of the patient had any CBD injury or iatrogenic complete cystic duct transaction or avulsion intra-operatively. None of the patient was found to have post-operative leak and readmission because of any complications of DCPS. **Conclusion**: DCPS can be performed safely during LC to clear cystic duct from stone/sludge.

INTRODUCTION

Laparoscopic cholecystectomy is an established operation for Cholelithiasis. Studies suggest that between 80-90% of patients experience symptom relief, with some reporting complete pain relief after this procedure. [1]. However, even after surgery, approximately 5% of patients might still experience upper abdominal pain. This persistent discomfort falls under the umbrella of post-cholecystectomy syndrome (PCS), a condition first described by Womack and Crider in 1947 [2]. Various factors can contribute to PCS, including biliary stricture, retained or recurrent gallstones, stenosis or dyskinesia of the sphincter of Oddi, stones in a gallbladder remnant or cystic duct stump, cystic neuroma.

One of the causes of post-cholecystectomy syndrome is cystic duct remnant calculus. Since Florcken first presented the idea of a "cystic duct remnant" in 1912, numerous researchers have studied this phenomenon with a variety of hypotheses [2,3]. In more than 50% of cases, the cystic duct has a length greater than 3 cm [4,5] and since small stones (<3 mm) may pass readily through the cystic duct downstream of the ligation and can be missed if not systematically sought. This may explain some cases of post cholecystectomy pain reported in the literature [4-5]. Cystic duct stone/sludge can act a nidus for CBD stones. Moreover, retained cystic calculi are difficult to diagnose and requires specific re-intervention [3]. Thus, it is imperative to confirm cystic duct clearance during cholecystectomy [4].

One of the ways to ensure the clearance of cystic duct is Intra Operative cholangiography; however, it also levies a financial burden, especially in settings where it is unavailable or feasible due to resource constraints such as cost, lack of expertise, or time limitations.

Intraoperative sweeping of cystic duct stump, named as 'semi-cut technique' is reported in the literature and revealed cystic duct stones/sludge in upto 22.2% [4, 6, 7]. Therefore, we have adopted intra-operative DCPS (Distal clipping and proximal sweeping) technique in which the surgeon clips the cystic duct at its junction with hartman's

pouch (Distal Clipping), performs an incision proximal to the clip (half of circumference of cystic duct), gently compresses the CBD from below upwards & sweeps cystic duct towards the incision till clear bile is observed. This ensures clearance of cystic duct of any residual stones or sludge which might subsequently migrate into CBD or serve as a nidus for stone formation.

Hence, we have conducted this study to determine the proportion of patients who achieve clearance of the cystic duct stump from stones or sludge using the Distal Clipping and Proximal Sweeping (DCPS) technique during laparoscopic cholecystectomy.

MATERIALS AND METHODS

This cross-sectional study was conducted on patients undergoing laparoscopic cholecystectomy (elective or emergency) by a consultant general surgeon or a registrar under supervision, in the Department of General Surgery at a tertiary care hospital in Karachi, Pakistan, from February to December 2023. Patients with Acalculous cholecystitis or in whom critical view of safety could not be achieved were excluded. Ethical approval was taken form ERC board (PH/IRB/2023/003) of hospital. The STROBE guidelines were used for conducting the study.

DCPS Technique

DCPS was performed in cases where critical view of safety was achieved and cystic duct is at least 2cm. It was performed by a single General surgeon or under his supervision by a surgical registrar who had experience in performing laparoscopic cholecystectomy. Anesthesia and surgical procedure were uniform for all patients. After establishing pneumo-peritoneum via Veress needle, pressure was set at 12–15 mmHg and four-port cholecystectomy was performed. Critical view of safety was achieved and cystic duct was measured using Kelly grasper (short prongs, fully opened equivalent to 2cm).

We used Common bile duct (CBD) as a proximal reference point being closer to body and Gallbladder distal to it. Distal Clipping was performed by applying a clip at the junction of Hartman's pouch and cystic duct to avoid backflow of bile and stones, followed by a 1-2mm incision by dissecting scissors in the cystic duct & extended anteriorly, leaving it intact posteriorly. CBD was gently swept with a suction nozzle or shaft of Kelly forceps starting above the duodenum and continued towards cystic duct till good flow of clear bile was achieved. In case free flow was not observed and stone/sludge was sensed in the cystic duct, then Cystic duct was gently milked between the prongs of Kelly forceps towards the incision. If free flow was not observed with these maneuvers, and impacted stone was suspected, the cystic duct was opened longitudinally downwards till stone was retrieved. Once free flow was achieved, two clips were applied proximal to the incision (towards CBD side) and cystic duct was transacted in between the clips (Figure 1). If stone or sludge was cleared out of cystic duct, DCPS was considered positive and it was clearly documented in the operative notes as well.

The gallbladder was removed from its bed using diathermy and retrieved through epigastric port in a gloved bag. Sheath and skin were closed. Patient was discharged next morning and scheduled for a routine follow up at around 14th post operative day. After that, patient only visited in case of emergency or any complaint. Data was collected about demographics, intra-operative findings including any complications occurred during DCPS, critical view of safety, outcome of DCPS and post operative outcomes i.e. leak or readmission by a single surgical resident (primary investigator) and Performa was filled. Sample size of 174 patient was calculated on OpenEpi sample size calculator, using the proportion of positive "semi cut" (DCPS in our study) in 22.2% patients [7] with bound on error of 6.2% and 95% confidence level.

Statistical Analysis

Data was entered and analyzed using the SPSS 22 version. Categorical variables such as gender, co-morbidities, history of cholecystitis, history of pancreatitis, history of ERCP, Stone impacted at cystic duct or Hartmann's pouch, Person performing DCPS were reported as frequencies and percentages. Numerical variables such as age and duration of surgery were reported as mean ± standard deviation.

RESULTS

A total of 174 Patients were enrolled in the study with the mean age of 47.11 ±14.37. There was a female predominance 103 (59.2%) and 99 patients had co-morbidities. (Table 1).

Most common indication for LC was Cholecystitis (i.e. 54 patients), 14 patients had history of pancreatitis, 20 had history of ERCP (endoscopic retrograde cholangiopancreatography) and 3 patients had cholecystostomy tube placed prior to Cholecystectomy as shown in Table 1.

Majority of patients (158) had multiple stones in lumen of Gallbladder on pre-operative ultrasound. None of the patients had any stone or sludge in cystic duct reported in preoperative ultrasounds. DCPS was performed by consultant in 92/174 (52.8%), rest by a surgical registrar. Mean ± SD Duration of Surgery in all patients was 76.59 ±20.62 minutes from incision to dressing (Table 1).

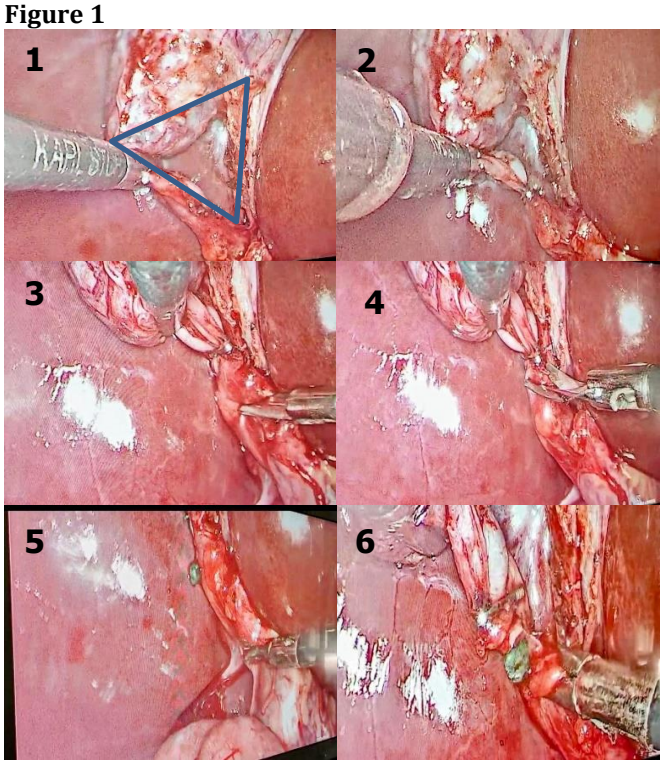
Table 1

Baseline Demographics of the Patients.

Features		n (%)
Age (years.); Mean ± SD		47.11 ±14.37
Gender	Male	71 (40.8%)
	Female	103 (59.2%)
Comorbidities	Diabetes	28 (16.1%)
	Hypertension	32 (18.4%)
	Multiple	25 (14.4%)
	Others	10 (5.7%)
	None	79 (45.4%)
	History of Cholecystitis	54 (31.0%)
	History of Pancreatitis	14 (8.0%)
	History of ERCP	20 (11.5%)
	History of Cholecystostomy	3 (1.7%)
No. of stones on pre-operative ultrasound	Multiple	158 (90.8%)
	Single	16 (9.2%)
Operating surgeon Performing DCPS	Consultant	92 (52.9%)
	Surgical Registrar	82 (47.1%)
	Duration of Surgery (mins); Mean ± SD	76.59 ±20.62
	Stones impacted at cystic duct or Hartmann (intra-operatively)	45 (25.9%)

Out of 174 patients, 84 patients (48.2%) were positive for stone/sludge in cystic duct during DCPS (26 for stones, 58 for sludge). (Figure 2) None of the patient had any CBD injury or iatrogenic complete cystic duct transaction or avulsion intra-operatively while doing DCPS technique. None of the patient was found to have post-operative leak and readmission because of any complications of DCPS.

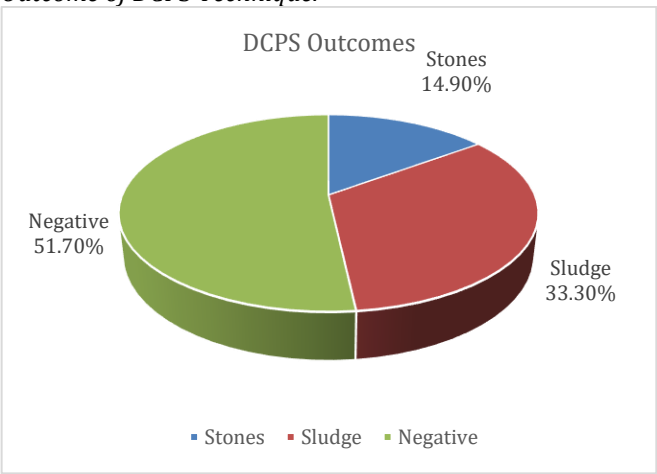
Figure 1



(1) Outlined triangle shows critical view of safety achieved, (2) Clipped applied first to distal end of cystic duct near Hartmann's pouch, (3, 4) A slit in the anterior wall of cystic duct being given below the proximal clip using scissors, (5) gently compressing the CBD from below upwards, (6) Sweeping of Cystic duct from its junction with CBD towards the slit with positive outcome of cystic duct stone.

Figure 2

Outcome of DCPS Technique.



DISCUSSION

The significant finding in our study, where 84 out of 174 patients (48.2%) were positive for stone/sludge in the cystic duct during DCPS (26 for stones, 58 for sludge), underscores the prevalence of occult cystic duct pathology that may otherwise go undetected. This highlights a critical need for effective intraoperative strategies to ensure complete biliary clearance.

Patients may experience persistent symptoms after cholecystectomy, often due to residual cystic duct stones. These symptoms, collectively known as post-cholecystectomy syndrome (PCS), can manifest as recurrent upper abdominal pain, dyspepsia, jaundice, pancreatitis, and general discomfort, sometimes accompanied by abnormal liver function tests and/or biliary obstruction. The reported incidence of PCS varies significantly, ranging from 10% to 30% of patients, with symptoms potentially appearing anywhere from a few days to two decades post-surgery [8,9]. Notably, one Italian study has reported an even higher incidence, reaching 47% [10].

The gold standard method of demonstrating biliary tree is direct cholangiography, where injection of contrast is performed with percutaneous transhepatic cholangiography, endoscopic retrograde cholangiopancreatography, or T-tube cholangiography [11,12]. Routine cholangiography, while effective in confirming cystic duct (CD) clearance, often presents significant hurdles. It can be a financial burden and is frequently unavailable or impractical in many locations due to limitations in resources like funding, specialized expertise, and time. A recent study has also shown that intra operative cholangiography may carry a false positive rate of 30–67%. The study also reported that nearly one-third of patients undergoing ERCP post laparoscopic cholecystectomy had normal postoperative ERCP. ERCP is an invasive procedure, associated with a complication rate of up to 11% even in experienced hands [13].

Given these limitations, we believe that less-invasive diagnostic approaches should be considered as alternatives to ERCP for patients. Our findings suggest that Distal Clipping and Proximal Sweeping (DCPS) offers an effective, and efficient way to ensure the cystic duct is clear.

In a retrospective study, Mahmud et al. (2001) reported cystic duct stones during LC in 64/520 (12.3%) [6]. The findings were then corroborated by another retrospective study by Sezeur et al. [4] in 2011, who reported Cystic Duct Lithiasis (CDL) in 21/142 (14.7%) by similar technique. Liu et al. conducted similar technique during LC in a prospective study and termed as "Semi cut", and reported cystic duct stone extraction in 10/45 (22.2%) [7]. We strengthened the existing evidence by; 1) conducting a prospective study on larger sample size, 2) surgery being performed by either a consultant or a registrar to document the safety of procedure and increase the generalizability, and 3) by documenting sludge as well as stones in cystic duct. In our study, 84 out of 174 patients (48.2%) were positive for stone/sludge in the cystic duct during DCPS; 26/174 (14.9%) for stones and 58/174 (33.3%) for sludge.

The DCPS technique is both safe and time-efficient. It can be executed within a few minutes by operating consultants or trained surgical assistants, including senior registrars and registrars. Although our study did not specifically

analyze the duration of DCPS, existing literature suggests that the procedure typically requires 3–5 minutes, with an average of approximately four minutes [7].

We didn't encounter any adverse event or short-term complication associated with our technique. Similarly, the study detailing the "Semi cut" technique didn't report any complication [7]. However, complications such as bile duct injury or inadequate stump to allow clipping are theoretically possible after DCPS especially in inexperienced or hasty hands. Therefore, to ensure patient safety and prevent bile duct injury, it's crucial to follow these precautions: 1) Achieve a critical view of safety through careful dissection, 2) Attempt DCPS when a minimum cystic duct length of 2 cm is achieved in order to have adequate length for clipping, 3) Perform a 1-2 mm incision in cystic duct & extend anteriorly and leave intact posterior wall to avoid avulsion, 4) Give gentle traction over hartman pouch to avoid avulsion, 5) Perform gentle sweeping of the CBD with a blunt instrument e.g. suction nozzle, 5) if 'milking' of cystic duct is required to clear stones, it should be performed with a Kelly forceps carefully & gently.

The systematic search for cystic duct stones during surgery is all the more justified because it is rarely detected by preoperative imaging of the bile ducts [4]. The normal cystic duct is seen only in 50% of the patients on ultrasound and is usually not visible on CT scans.[12]. Magnetic resonance cholangiopancreatogram (MRCP) can demonstrate entire course of the normal cystic duct but is not routinely performed before laparoscopic cholecystectomy [12]. This suggests that if DCPS hadn't been performed, all 84 of these patients (26 with stones and 58 with sludge) would have likely experienced ongoing symptoms due to retained stone/sludge as well as a future risk of choledocholithiasis.

Limitations of our study include single arm nature with short term follow up and lack of exact operating time of DCPS. We recommend a prospective cohort study or randomized controlled trial with long term follow up for deranged LFTS and confirmatory imaging and comparison of post-cholecystectomy syndrome in patients having DCPS versus no DCPS.

CONCLUSION

Our study demonstrates that Cystic duct stone or sludge is commonly found in patients undergoing Laparoscopic cholecystectomy, and DCPS is a safe, cost effective and reproducible maneuver to confirm cystic duct clearance at the time of surgery.

Availability of Data: Authors confirm that data supporting the results of this study are available in the article.

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Author's Contribution

- Study concept: KA, GM, SB
- Designing: KA, GM, SB, FA
- Result, analysis and interpretation: KA, GM, SJ, FA
- Manuscript drafting: KA, GM, SB, FA, SJ
- Critical review and revision of initial draft: KA, GM, FA, SB, SJ

This manuscript has been read and approved by all authors.

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