

Research Article

Nigam's Classification of Subtotal Cholecystectomy According to the Level of Resection (NCSC-LR)

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Abstract

Subtotal cholecystectomy is performed in difficult gallbladder where total cholecystectomy is avoided due to risk of bile duct injury and other complications as the structures of Calot's triangle are difficult to identify due to severe inflammation, fibrosis and dense adhesions. The remnant gallbladder can cause early and late complications such as bile leak, recurrence of stone formation and acute stump cholecystitis. The knowledge of size of remnant gallbladder in advance can help in diagnosis and decision making for handling the remnant gallbladder complications. Nigam's Classification of Subtotal Cholecystectomy according to the Level of Resection (NCSC-LR) plays an important role in such situations and helps the treating surgeon in diagnosis and treatment of post subtotal cholecystectomy complications by knowing the level of resection (size of remnant gallbladder) as per previous operation notes.

Keywords

Adhesions, Calot's Triangle, Gallbladder, Level of Resection, NCSC-LR, Subtotal Cholecystectomy, Total Cholecystectomy

1. Introduction

1.1. Anatomy

Gallbladder is a pear shaped (pyriform) organ located on the undersurface of the liver on segments IV B and V. It is 7.5 to 10 cm long and 5 cm wide with a capacity of 30-50 ml. It has following parts: (Figure 1).

1.1.1. Fundus

The rounded part of its distal portion projecting out from the inferior surface of the liver.

1.1.2. Body

It is the main part of gallbladder situated between the fundus and the neck.

1.1.3. Infundibulum

It is the tapering segment of the gall bladder between body and neck of the gallbladder. Sometimes clinicians call the infundibulum as neck due to no clear demarcation. Hartmann's pouch is located in the infundibulum. It is common site of stone impaction. A large stone in the infundibulum can press the common bile duct (CBD) and can cause biliary obstruction called Mirizzi syndrome.

1.1.4. Neck

It is the part of the gallbladder connecting infundibulum

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with the cystic duct.

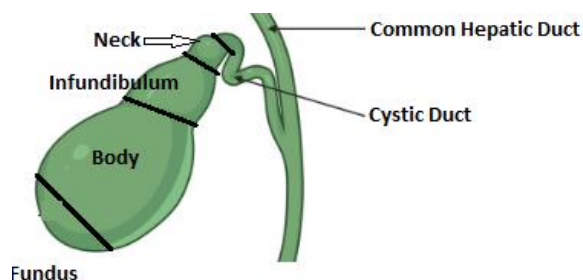


Figure 1. Parts of gallbladder.

Gallbladder stores and concentrates bile, facilitating fat digestion [1].

1.2. Gallbladder stones and NCSC-LR

Gallstone disease is a major health problem that affects 1 to 4% of the Western World population every year and almost 10 to 15% during their lifetime [2]. The estimated prevalence of gall stones in the Indian population ranges from 2-9%. According to a study, gall bladder stones occurred 7 times more commonly in North Indian population than South Indian population [3, 4], but the scenario is gradually changing and such difference in the incidences of gallstones is reducing fast. Fifth and sixth decade of life has higher incidence of gallstones with more prevalence in women. Several authors have confirmed that females had a greater prevalence of cholelithiasis than males [5, 6]. Gallstones become more likely as you become older [7].

Difficult gallbladder where critical view of safety cannot be achieved requires subtotal cholecystectomy or conversion to open cholecystectomy. If difficult gallbladder can be suspected or predicted preoperatively then it makes less chances of developing postoperative complications as the surgeon knows preoperatively exactly what should be done and plans accordingly. Difficulty in cholecystectomy can be predicted in a preoperative manner by using clinical, radiological and laboratory findings, however, it becomes apparent only intraoperatively [8]. Preoperative prediction of difficult cholecystectomy can be done with the help of scoring system of severity such as NACSS (Nigam's Acute Cholecystectomy Scoring System according to Level of Resection).

Subtotal cholecystectomy is the removal of gall bladder leaving behind a part of it in difficult gallbladder due to risk of injury as the dissection in Calot's triangle is not possible due to fibrosis or adhesions causing identification of anatomical structures difficult or not possible [9]. Subtotal cholecystectomy is considered the best "bailout technique" when it is not possible to reach the critical view of safety during difficult cholecystectomy. However, the risk of postoperative gallstone recurrence remains controversial [10].

A large remnant gallbladder after subtotal cholecystectomy

is associated with an increased risk of late postoperative complications. Though there is not a guiding line for ideal size of remnant gallbladder but to avoid late complications the size of remnant gallbladder should be as small as can be. The current recommendation is to remove as much of the gallbladder wall as possible and ensure the complete removal of any stones [11].

Teshima T et al. reported that, there was a significant correlation between remnant gallbladder diameter and long-term complications. Due to the size of the remnant gallbladder in both our cases, 38 x 36 mm and 47 x 29 mm, respectively, they had a higher risk for long term complications [12].

In this study we are classifying the subtotal cholecystectomy as per anatomical level of resection of gall bladder such as through lower part of body or infundibulum or neck. This classification divides the subtotal cholecystectomy in 3 levels. (Level I, II & III). The knowledge of level of resection of gallbladder is very important in long term follow-up of cases of subtotal cholecystectomy as it can help the treating surgeon when a late post-subtotal cholecystectomy complication develops such as retained or recurrent gall stone, cholecystitis of remnant gallbladder tissue, bile leak and its collection, biliary fistula and biliary stricture. Post cholecystectomy syndrome – can present early, typically in the post-operative period, but can also manifest months to years after surgery [13].

NCSC-LR gives an idea about what portion of gallbladder was left in subtotal cholecystectomy. If the first surgery, subtotal cholecystectomy operation notes can show the level of anatomical resection of the gallbladder, indicating the size or amount of remnant gallbladder then the surgeon treating at the time of development of complication can precisely predict the type of problem by diagnosing it through level of resection as with level I stone and cholecystitis are more common than level III where biliary stricture is common. If surgeon knows the level of resection in previous surgery then it is clear for surgeon that what should be suspected i.e. recurrence of stone, remnant cholecystitis, or biliary stricture.

2. Material and Methods

2.1. Patient Selection

Twenty-five cases of difficult gallbladder were operated by subtotal cholecystectomy between June 2019 to April 2025 at Max Hospital, Gurgaon, Haryana, India. Routine preoperative investigations including ultrasound of abdomen were done in all cases. Informed written consent was taken from each patient (laparoscopic/open cholecystectomy). All cases of acute abdomen who were tentatively diagnosed as cases of acute cholecystitis in emergency department were included in this study. Cases of gall bladder disease other than cholecystitis with or without complications were excluded. All these cases were admitted through emergency department. All cases were operated by laparoscopic cholecystectomy and some cases were converted to open surgery. Subtotal cholecystectomy

during the operation was chosen to avoid injury to bile ducts and other organs due to dense and cementing adhesions in and around Calot's triangle (frozen Calot's triangle). We have resected the gall bladder at different levels due to inability to proceed with dissection further without causing injury to bile duct and vessels due to fibrosis, severe adhesions leading to poor identification of anatomical structures at Calot's triangle and around it. We classified the level of resection as following:

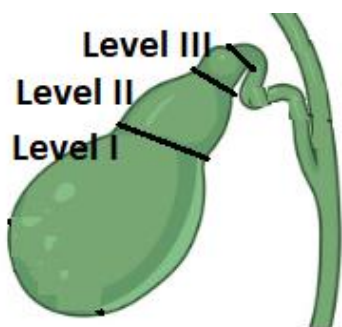


Figure 2. Levels of resection of gallbladder, in subtotal cholecystectomy.

Level I (through lower part of the body of gallbladder), Level II (through infundibulum), Level III (through neck).

The level of resection of gallbladder decides the level in NCSC-LR (Figure 2).

Level I – Resection through lower part of the body of gallbladder

Level II - Resection through the infundibulum

Level III - Resection through the Neck

Levels give information about the size of remnant gallbladder so in the operation notes of subtotal cholecystectomy the level of resection must be entered.

2.2. Surgical Procedure

Most of cases in our study were operated by subtotal reconstituting cholecystectomy. The resection was done laparoscopically through Level I or II or III by starting dissection around the neck or infundibulum or just above it. Few cases needed conversion to open cholecystectomy due to extreme adhesions or perforation or gangrene of gallbladder. We did fundus first method of dissection in all cases of open cholecystectomy as the dissection at Calot's triangle was found to be difficult and dangerous. First, we opened the gallbladder at the fundus, suctioned out the bile and removed the stones. Dissection started from fundus separating gallbladder till near Hartmann's pouch. All the visible bleeders at liver bed and bile leaking ducts (Ducts of Lushka) were cauterized. In cases where cirrhotic liver was also present (2 cases, 8%) we took extra precaution and started the dissection at junction of liver

and gallbladder leaving a thin slice of gallbladder wall, not the full thickness, without opening the gallbladder. It is called cystic plate approach. The cystic plate is a sheet of fibro-areolar tissue located in the gallbladder bed. The cystic plate is an essential structure for surgical techniques in liver surgery [14]. Small bile ducts may drain from liver parenchyma to the gallbladder through the cystic plate [15]. Dissection was performed close to the cystic plate on the gallbladder side to protect any other aberrant structure from passing across this potential space. (Ducts of Lushka). We did the dissection to separate gallbladder from liver through this plate by electrocautery and blunt dissection. Gallbladder bed was dealt with electrocoagulation. In open subtotal cholecystectomy we started cystic plate dissection at fundus but in laparoscopic subtotal cholecystectomy we started from the neck or infundibulum.

It is always a matter of experience to find this cystic plate plane of dissection with minimal bleeding and without entering the lumen of gallbladder. All bleeders even small, must be cauterized. Gallbladder was ligated at different levels according to the extent of adhesions and limitation of dissection. In 3 cases we had to use gel sponges (absorbable hemostatic gelatin sponge) to control bleeding and avoid postoperative bleeding and haematoma formation. Bile cultures were sent where indicated. Drains were placed in all cases.

2.3. Postoperative Management

All cases received postoperative antibiotics. In all cases we closed the opening of remnant part of gallbladder (reconstituting subtotal cholecystectomy). All cases did well post operatively and did not develop any major complications. Bile leak continued for 15 to 20 days in 3 cases and gradually subsided. Majority of the bile leaks resolved within 2 weeks.

2.4. Outcome Measures

None of the patients required any interventions for stopping bile leak. One patient had a collection at gallbladder fossa which was managed conservatively. The follow up was done from postoperative period to approximately 6 years. During this follow up period we came across only one case of post-subtotal cholecystectomy cholecystitis.

3. Results

In this study of 25 patients, 6 cases were male (24%) and 19 were female (76%). Most of the patients belonged to 31-50 years age group. Maximum number of (16, 64%) cases belonged to acute on chronic cholecystitis with cholelithiasis. Three cases (12%) of empyema and 6 (24%) cases of gangrene of gallbladder were also encountered in our study.

Table 1. Distribution of cases as per diagnosis.

Type of Gallbladder diseases	Number of patients	Percentage
Acute on chronic cholecystitis with cholelithiasis	16	64%
Empyema of gallbladder	3	12%
Gangrene of gallbladder	6	24%

(n=25)

Out of 25 patients in our study 15 patients (60%) belonged to Nassar scale grade 3 and 9 (36%) to grade 5 (Table 2). The Nassar operative difficulty scale is a simple 4-point scale

published in 1995 and has been used in prospective single region series which included data from 4089 patients [16].

Table 2. Distribution of cases according to Nassar scale grading of difficulty.

Nassar Scale	Number of patients	Percentage
Grade 1 (Early Cholecystectomy with gallbladder without adhesions)	0	0%
Grade 2 (Difficult gallbladder with simple adhesions)	0	0%
Grade 3 (Challenging cholecystectomy contracted or fibrotic gallbladder with adhesions to hepatic flexure of colon or duodenum)	15	60%
Grade 4 (Dense adhesions, completely obscured gallbladder, or gangrenous gallbladder)	10	40%

(n=25)

Out of 25 cases maximum number of 17 cases (68%) had resection at infundibular region (level II, figure 4), in 6 cases (24%) resection was done at neck of gallbladder (Level III, figure 5) and in 2 cases (8%) the resection was done at lower part of body of gallbladder (Level I, figure 3). (Table 3).

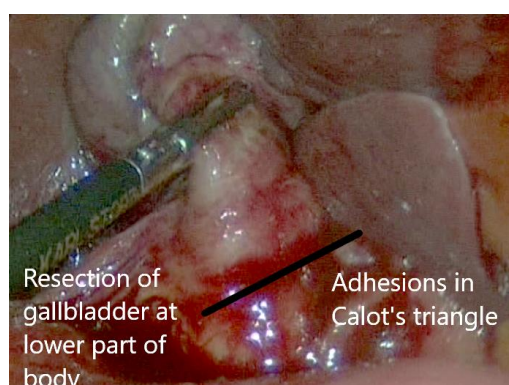
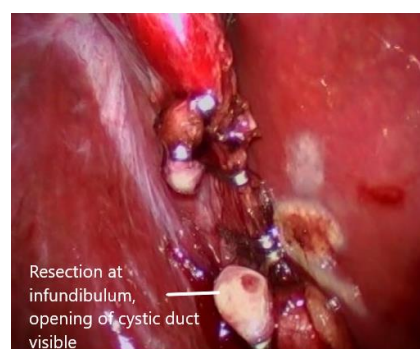
**Figure 3.** Level I subtotal cholecystectomy.**Figure 4.** Level II subtotal cholecystectomy.**Figure 5.** Level III subtotal cholecystectomy.

Table 3. Distribution of cases according to NCST-LR.

Levels	Number of cases	Percentage (%)
Level I	2	8%
Level II	17	68%
Level III	6	24%

(n=25)

Out of 25 cases of subtotal cholecystectomy in our study 11 cases (44%) were converted to open cholecystectomy due to difficult gallbladder and 14 cases (56%) underwent laparoscopic cholecystectomy. (Table 4).

Table 4. Distribution of cases according to types of cholecystectomy.

Type of cholecystectomy	Number of patients	Percentage
Open cholecystectomy	11	44%
Laparoscopic cholecystectomy	14	56%

(n=25).

In our study, no patient developed serious postoperative complication. Few cases had mild bile leak which lasted for few days and stopped without any surgical intervention. (Table 5).

Table 5. Post-operative complications.

Post-operative complications	Number of patients	Percentage
Bile leak 0-5 days (through drain)	6	24%
Bile leak 6-14 days	3	12%
Bile leak 15-20 days	3	12%
Collection at gallbladder fossa	1	4%

(n=25).

4. Discussion

The cases which were converted to open subtotal cholecystectomy were intra-operatively diagnosed as cases of acute on chronic calculous cholecystitis, dense adhesions, empyema of gallbladder, frozen Calot's triangle and gangrene of

gallbladder, where the structures of the Calot's triangle cannot be identified and the critical view of the safety cannot be achieved [17]. This study though has a low number of cases, explains well when and how to do STC.

About 5 to 25% persons after cholecystectomy can develop gallstones again after few years. Some early studies [18, 19] showed that 5-year recurrence rate of gall stone was >30% after laparoscopic cholecystectomy combined with choledochoscopic lithotomy. Unfortunately, between 5 and 47% patients present postoperative with recurrent gastrointestinal symptoms such as abdominal pain, dyspepsia, nausea, vomiting, fever, diarrhea and jaundice [20-23].

Cholecystectomy is one of the most common abdominal operations performed worldwide. The operation can be technically difficult owing to dense adhesions in Calot's triangle. Conversion to open surgery or subtotal cholecystectomy has been described to deal with these situations [24, 25].

The first cholecystectomy was performed by Carl Langenbuch in the Lazarus hospital of Berlin on 15 July 1882 [26]. In 1878, James Marion Sims introduced the term cholecystectomy [27]. Muhe (1985) and Mouret (1987) [28] introduced laparoscopic cholecystectomy and later laparoscopic SC was considered a rescue technique in cases of difficult GBs to avoid misidentification injuries of the bile duct and vascular structures for severe inflammations that otherwise would have required conversion to an open cholecystectomy [9, 29-31]. The term partial cholecystectomy was emphasized by Estes in 1931, while 'subtotal cholecystectomy' was introduced by Morse and Barbon 1947. Madding and Farrow popularized it.

Subtotal cholecystectomy usually is performed for difficult GBs in which the degree of inflammation, fibrosis, and adhesions significantly increase the risk of complications, especially CBD injuries [32, 33]. Partial cholecystectomy (leaving a cuff of gallbladder in situ) can be a good option in the context of acute inflammation since potentially hazardous dissection of Calot's triangle is avoided [34]. However, it is important to ensure that the remnant of gallbladder that is left is free of stones and also that this portion of gallbladder is small [35]. Studies of post-cholecystectomy patients records show continued symptoms in upto 50% of patients [36, 37]. The only certain way to prevent recurrence of gallstones in the gall bladder is total cholecystectomy.

Henneman et al. reported only one bile duct injury in 625 laparoscopic subtotal cholecystectomies [17]... In contrast, long-term complications associated with remnant gallbladder have been reported [38, 12]. Indeed, Kohga et al [39]. reported that 1 of 35 patients (3%) who underwent subtotal cholecystectomy developed remnant cholecystitis.

In re-exploration of a case with history of subtotal cholecystectomy, dense adhesions are expected of colon, duodenum and omentum with gallbladder fossa. Adhesiolysis or biliary dissection leads to organ injury if the surgeon is not well experienced with a high degree of precision. Palanivelu and Chowbey reported good results in cases with major

postoperative complications [40-42].

The terms 'partial cholecystectomy' and 'subtotal cholecystectomy' indicate same operation i.e. incomplete removal of gallbladder. In 2015 Strasberg, et al., recommended that the term subtotal cholecystectomy should be used in place of all possible terms related to partial cholecystectomy [43].

Subtotal cholecystectomy is an umbrella term for incomplete cholecystectomies. 'Subtotal open tract cholecystectomy' and 'Subtotal closed tract cholecystectomy' are the terms that characterize the type of completion of subtotal cholecystectomy [44]. Subtotal cholecystectomy technically can be called as incomplete cholecystectomy or partial cholecystectomy. Incomplete gallbladder surgery, involving leaving a long cystic duct or gallbladder remnant, for example can occur in both open and laparoscopic procedures [45]. Subtotal cholecystectomy was first reported by Madding in 1955 [46, 29].

Subtotal cholecystectomy is a bail-out procedure undertaken when facing difficult laparoscopic cholecystectomy due to not achieving the critical view of safety, inadequate identification of the anatomical structures involved and / or risk of injury [47]. It was 'invented' by Max Thorek of Chicago some 100 years ago and has since been practiced by 'wise surgeons' (including us of course) – a technique which every surgeon has to master (*M Schein*). Cholecystectomy difficulty can be predicted in a preoperative manner by using clinical radiology and laboratory findings. However, it becomes apparent only intraoperatively [8]. Such cases are difficult not only laparoscopically but also by even open surgery.

Subtotal cholecystectomy's proportion oscillates between 4.06% to 9.38% [48-52]. Subtotal cholecystectomy is a procedure that has only become more relevant with pass of time; with higher performance rates now more than ever [53]. Now that laparoscopic cholecystectomy is more commonly performed. Open cholecystectomy has reduced in number in today's minimal invasive surgery era. Asher Hirshberg MD, summarized subtotal cholecystectomy aptly: "It is better to remove 95% of the gallbladder [i.e., subtotal cholecystectomy] than 101% [i.e., together with a piece of the bile duct]" [54]. Newer generation surgeons seem to have a lower degree of expertise when performing open cholecystectomy and as a result prefer performing subtotal laparoscopic cholecystectomy over former [55].

Fibrosis, dense adhesions and inability to recognize structures in Calot's triangle can make cholecystectomy difficult. Such conditions if provided then it can lead to serious iatrogenic biliary duct injuries. So it is advisable to go for subtotal cholecystectomy rather total cholecystectomy. Strasberg, et al, divided subtotal cholecystectomies into "fenestrating" and "reconstituting" types based on if remaining portion of gallbladder was left open or closed [24]. Stasberg et al. reported that, 'Subtotal reconstituting cholecystectomy closes off all the lower end of the gallbladder, reducing the incidence of postoperative fistula, but creates a remnant gallbladder which may result in recurrence of symptomatic cholecystoli-

thiasis for level II subtotal cholecystectomy. One has to be extremely careful while doing completion cholecystectomy laparoscopically or open cholecystectomy. Nevertheless, one of the major complications is bile duct injury [56, 57], a catastrophic complications that can even reduce long-term survival [58]. The closure of the left-over portion of gallbladder in reconstituting subtotal cholecystectomy is done by intracorporeal sutures or endoloop or stapler or clips or an omental plug. We close by sutures and always put an abdominal drain.

'Difficult gallbladder' denotes the condition where removal of gallbladder safely without causing any iatrogenic injury to the biliary tract and surrounding important structures becomes difficult due to inflammation, dense adhesions, frozen Calot's triangle and biliary and vascular anomalies. In such cases, the structures of the Calot's triangle become very difficult to be identified anatomically. "Difficult gallbladder" (GB) is a procedure with an increased surgical risk compared with standard cholecystectomies [59, 60].

In 1898, Hans Kehr [61] operated a 27-year-old woman with acute cholecystitis, due to difficult conditions, he removed the gall bladder leaving behind the posterior wall and the part of the bladder next to cystic duct. This seems to be the first description of a modification of cholecystectomy due to difficult operative conditions [62]. Probably it was the first subtotal cholecystectomy.

Residual gallbladder diseases like stone and cholecystitis after cholecystectomy and subtotal cholecystectomy require suspicion if patient develops abdominal symptoms like pain in RUQ, dyspepsia, nausea & vomiting even after years. Zhu, et al. reported that three of their 11 cases were erroneously diagnosed with esophagitis and/or gastritis prior to definitive treatment [63]. Recent studies have suggested that there is a direct correlation between the diameter of the stump created post-surgery and long-term complications. Larger gallbladder stumps were found to be associated with more long-term complications [49]. We have observed same in level I.

The barrier to diagnoses was insufficient information about previous cholecystectomy or subtotal cholecystectomy. When assessing a patient with post cholecystectomy symptoms, one must carefully review the operative history [64]. Here comes the role of NCSC-LR as by mentioning in operation notes of subtotal cholecystectomy the level of resection Level I, II or III, alleviates all confusion and diagnosis can be made easily and definitely. In most cases of previous operation notes commonly found mentioned were terms such as 'severe inflammation' or 'dense adhesions' or 'difficult cholecystectomy' or a 'subtotal cholecystectomy' was performed due to difficulty, but nothing about the level of resection of gallbladder (Level I, II or III) or how much gallbladder was left (the size of remnant gallbladder).

To diagnose the cause of recurrence of symptoms of stone or cholecystitis USG, CT scan, MRCP, HIDA scan and ERCP are usually performed but sometimes mystery remains and here the knowledge of level of resection of gallbladder solves the problem.

Level I resection of gallbladder has a sizable remnant gallbladder so it is most prone to the formation of new stones and also the chance of acute cholecystitis, the level III resection at the neck of gallbladder should have the lowest incidence of stone formation and acute cholecystitis. So the remnant part of gallbladder should be left as small as possible to reduce the incidence of recurrence of stone formation and remnant cholecystitis as the link between late complications of subtotal cholecystectomy and size of remnant gallbladder are well proven. We did not leave the posterior wall of gallbladder with mucosal lining in any case. In the setting of severe inflammation, SC has been associated with reduced rates of BDI compared with total cholecystectomy. In our series we did not come across any BDI. Subtotal cholecystectomy is a useful strategy for the avoidance of BDI when the critical view of safety cannot be achieved [65].

As surgeons become less familiar with technical aspects of open cholecystectomy, laparoscopic bail-out maneuvers will be increasingly relevant [66]. Difficult LC has a risk of BDI which is 3 to 5 times higher in laparoscopic than open surgery. In case of operative difficulties, as young surgeons mostly trained in laparoscopy the help of senior surgeon is strongly recommended [49, 67]. Many contemporary surgeons undertaking cholecystectomy may not have expertise in performing this as an open procedure, which has its own challenges due to working in a deep pocket without the illumination and magnification of a laparoscope [68].

In difficult gall bladder going for level III (resection at the neck of gallbladder) subtotal cholecystectomy can be risky due to chances of BDI, it is better to go for level I. To avoid or reduce the post cholecystectomy late complication the size of remnant of the gallbladder is very important but BDI risk should not be taken in lieu of the small portion of remnant gallbladder. Depending upon the extent of the resection and the structures left in situ, there is a definite risk of recurrence of symptoms, including recurrent acute cholecystitis [35], gallstone pancreatitis [69], and choledocholithiasis. According to the literature, 10%-30% patients continue to suffer right upper quadrant pain and dyspepsia following cholecystectomy and are suspected of having postcholecystectomy syndrome [13]. The cause of postcholecystectomy syndrome include cystic duct stump stones, CBD stones and biliary strictures [70, 71].

The knowledge of level of resection of gallbladder site (Level I, II or III) in previously done subtotal cholecystectomy will not only predict the cause of RUQ pain and tenderness but also help surgeon in preoperative information about difficulty in completion cholecystectomy. After a partial or subtotal cholecystectomy symptoms may recur from pathology in the gallbladder remnant. When this occurs, a completion cholecystectomy is required to prevent a recurrence [72]. The completion cholecystectomy in follow up cases of subtotal cholecystectomy is a difficult dissection and risky too, due to dense cementing adhesions. We feel that completion cholecystectomy may be more difficult after

Level III subtotal cholecystectomy than Level I subtotal cholecystectomy due to dense adhesions and proximity to CBD. Completion after Level III subtotal cholecystectomy has high chances of CBD injury. Therefore, completion cholecystectomy should be done only if the recurrent or persistent biliary symptoms are troublesome and affect QOL.

Completion cholecystectomy may be required maximum in Level I subtotal cholecystectomy cases and minimum in Level III subtotal cholecystectomy due to the size of remnant gallbladder. Cawich et al mentioned in their study that, 'Many of their patients were traditionally subjected to open cholecystectomy because the laparoscopic approach was anticipated to be technically challenging [73]. We agree with it and feel that it will be more with Level I than Level II and Level III subtotal cholecystectomy.

The advantages of mentioning levels NCSC-LR on operation notes of subtotal cholecystectomy are many:

- 1) It indicates the size of remnant gallbladder, more in Level I than Level III.
- 2) Chance of recurrence of stone and remnant cholecystitis is more with Level I than Level III.
- 3) Completion cholecystectomy will be more difficult in Level III than in Level I.
- 4) CBD injury chances in completion cholecystectomy is more in Level III than Level I.
- 5) Completion laparoscopic cholecystectomy in Level III should not be attempted by inexperienced surgeon. It requires an experienced surgeon, even then it is difficult.
- 6) Patient can be referred to a higher center if laparoscopic completion cholecystectomy is required for Level III case.

5. Limitation

In our study the research is done at one center only and by one team of surgeons. This study is having small number of subjects which limits the outcome universally so a study involving large number of patients is required to form a definite guideline about the level of resection of gallbladder as Level I, II and III.

6. Future Research Directions

The anatomical levels of dissection is an idea for young surgeons and also senior surgeons doing subtotal cholecystectomy to include it in the discharge slip of patient clearly so that in future if a patient presents with features of acute cholecystitis, gall bladder stones, biliary stricture and biliary fistula, the treating surgeon can diagnose easily without abandoning the diagnosis of gallbladder disease as the gallbladder was removed in previous surgery. It should be made mandatory to include the level of resection (Level I, II, III) of the gallbladder in discharge slip after subtotal cholecystectomy. The system of level of resection of gallbladder in

subtotal cholecystectomy (Level I, II, III) is an ideal future research direction to ease the diagnosis, when recurrence of symptoms occur.

7. Conclusion

We have presented classification of subtotal cholecystectomy by anatomical level of resection of gallbladder (NCSC-LR). This classification describes 3 levels (Level I, Level II and Level III) indicating the level of resection of gallbladder at lower part of body of gallbladder, infundibulum and neck respectively. The levels clearly give information to the surgeon dealing with late complications of subtotal cholecystectomy about the size of remnant gallbladder. This information will help the surgeon to reach at an early diagnosis in recurrence of biliary symptoms and also for completion cholecystectomy.

Abbreviations

NCSC-LR	Nigam's Classification Of Subtotal Cholecystectomy According To The Level of Resection
CBD	Common Bile Duct
BDI	Bile Duct Injury
STC	Subtotal Cholecystectomy
LC	Laparoscopic Cholecystectomy
GB	Gallbladder
QOL	Quality of Life
RUQ	Right Upper Quadrant
USG	Ultrasonogram
CT Scan	Computed Tomography Scan
MRCP	Magnetic Resonance Cholangiopancreatography
HIDA Scan	Hepatobiliary Iminodiacetic Acid Scan
ERCP	Endoscopic Retrograde Cholangiopancreatography

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Declaration of Patient Consent

Informed consent was taken from patients.

Author Contributions

Vinod Kumar Nigam: Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Validation, Writing – original draft

Siddharth Nigam: Data curation, Formal Analysis,

Methodology, Software, Visualization, Writing – review & editing

Dr. Vinod Kumar Nigam introduced the concept of the research and design of the work. Dr. Siddharth Nigam worked for data acquisition, analysis and interpretation of data along with selection of photographs.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Standerling S. Gray's Anatomy: The Anatomical Basis of Clinical Practice 42nd ed. 2021. Chapter 67: p1217-1222.
- [2] Sanders G, Kingsnorth AN. Gallstones. *BMJ*. 2007; 335(7614): p295-299. <https://doi.org/10.1136/bmj.39267.452257.AD>
- [3] Malhotra SL. Epidemiological study of cholelithiasis among railroad workers in India with special reference to causation. *Gut* 1968; 9: p290-295. <https://doi.org/10.1136/gut.9.3.290>
- [4] R. K. Tandon, Prevalence and types of biliary stones in India. *World J Gastroenterology* Sept 2000; 6(Suppl 3): p4-5. <https://doi.org/10.3748/wjg.v6.iSuppl3.4>
- [5] Sarda DK. Prevalence and management of cholelithiasis in population of Rajasthan: a clinical study. *J Med Sci Clin Res*. 2018; 8: p2021. <https://dx.doi.org/10.18535/jmscr/v6i2.27>
- [6] S Dr. Cholelithiasis: a study in clinical presentation and management. *Int. J. Surg. Sci*. 2020; 4: p308-310. <https://doi.org/10.33545/surgery.2020.v4.i1f.355>
- [7] Shaffer EA. Gallstone disease: epidemiology of gallbladder stone disease. *Best Pract Res Clin Gastroenterol* 2006; 20: p981-996. <https://doi.org/10.1016/j.bpg.2006.05.004>
- [8] Srinivas S, Hammil CW, Strasberg SM. How to do laparoscopic subtotal fenestrating cholecystectomy. *ANJ J Surg*. (2021); 91(4): p740-1. <https://doi.org/10.1111/ans.16435> Epub 2020 Nov 16
- [9] Mohamed E, Gianpiero G, Katie T, et al. Subtotal cholecystectomy, for difficult gallbladders – Systematic Review and Meta-analysis. *JAMA Surg*. 2015; 150(2): p159-168. <https://doi.org/10.1001/jamasurg.2014.1219>
- [10] Soreide K. Gallstone disease and cancer risk: finding the bug in the system. *Gastroenterology* 2017; 152: p1825-8. <https://doi.org/10.1053/j.gastro.2017.04.028>
- [11] Mateja HL, Rowe DA, Tsai A, Giuseppucci P. Remnant Cholecystitis After Subtotal Cholecystectomy: A Case Report *Curues*. 2024 Oct 17; 16(10): e71719. <https://doi.org/10.7759/curues.71719>
- [12] Teshima T, Nitta H, Takamori H. How to treat remnant cholecystitis after subtotal cholecystectomy: two case reports, *surg case rep*. 2021; 7: p109. <https://doi.org/10.1186/s40792-021-01183-x>

- [13] Zackria R, Lopez RA. Postcholecystectomy Syndrome. [Updated 2023 Aug 28]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK539902/>
- [14] Tokumitsu Y, Tamesa T, Shindo Y, Sakamoto K, Nagano H. Application and utility of surgical techniques for cystic plate isolation in liver surgery. *Ann Gastroenterol Surg*. 2022 Mar 22; 6(5): p726-732. <https://doi.org/10.1002/ags3.12568>
- [15] Zhou Y, Xiao L, Luo Z, Luo H, Jan Z, Wang T. Cystic plate approach in laparoscopic cholecystectomy: a consecutive retrospective analysis. *Front Surg*. 2024 Dec 3; 11: 1487568. Volume 11 - 2024 | <https://doi.org/10.3389/fsurg.2024.1487568>
- [16] Griffiths EA, Hodson J, Vohra RS, Marriott P, The Choles Study Group, Ketheb T, Zino S, Nassar AHN, and West Midlands Research Collaborative. *Surg. Endosc*. 2018 August 22; 33(1): p122. <https://doi.org/10.1007/s00464-018-6377-8>
- [17] Henneman D, daCosta DW, Vrounacts BC, Van Wagenveld BA, Lagarde SM. Laparoscopic partial cholecystectomy for the difficult gallbladder: a systematic review. *Surg Endosc*. (2013) 27(2): p351-8. <https://doi.org/10.1007/s00464-012-2458-2>
- [18] Zhu YP, Du JD, Li WM, Xiao YQ, Xu HB, Zheng F, et al. Gallstone recurrence after successful percutaneous cholecystolithotomy. A 10-year follow up of 439 cases. *Hepatobiliary Pancreat Di Int*. 2077; 6: p199-203. PMID: 17374582.
- [19] De Caluwe D, Akl U, Corbally M. Cholecystectomy versus cholecystolithotomy for cholelithiasis in childhood: long term outcome. *J Pediatr Sug*. 2001; 36: p1518-21. <https://doi.org/10.1053/jpsu.2001.27035>
- [20] Glasgow R, Mulvihill S. Treatment of gall stone disease. In Fildman M, Frideman L, Brandt L (8th Ed.) *Sliesenger & Fordtran's gastrointestinal and liver diseases*, Saundry Philadelphia p1419-1437.
- [21] Bisgard T, Rosenberg J, Kehlet H from Acute to chronic pain after laparoscopic cholecystectomy: A prospective follow-up analysis. *Scand J Gastroenterol* 2005; 40: p1358-1364. <https://doi.org/10.1080/00365520510023675>
- [22] Russello D, Di Stefano A, Scala R, Favetta A, Emmi S, Guastella T, et al. Does cholecystectomy always resolve biliary disease? *Minerva Chir* 1997; 52: p1435-1439. PMID: 9557456.
- [23] Anand A, Sharma R, Kapur B, Tandon R. Analysis of symptomatic patients after cholecystectomy: Is the term post-cholecystectomy syndrome and anachronism? *Imp Gastroenterol* 1995; 52: p1435-1439. PMID: 8644362
- [24] Fugger R Challenging situations in cholecystectomy and strategies to overcome them. *Eur Surg*. 2021; 53: p106-113. <https://doi.org/10.1007/s10353-020-00687-4>
- [25] Eikermann M, Siegel R, Broeders et al. Prevention and treatment of bile duct injuries during laparoscopic cholecystectomy: the clinical practice guidelines of the European Association of Endoscopic Surgery (EAES). *Surg Endosc* 2012; 26: p3003-3039. <https://doi.org/10.1007/s00464-012-2511-1>
- [26] Ellis H. *Surgical Case-Histories for the Past*. Royal Society of Medicine Press Limited; London, UK: 1994. Chapter 9: Carl Langenbuch. The first cholecystectomy (1882), p57-61.
- [27] Sims JM. Cholecystectomy for the removal of gall-stones in dropsy of the gall-bladder. *Br. Med. J*. 1878; 1: p811-815. <https://doi.org/10.1136/bmj.1.910.811>
- [28] Horiuchi A, Watanbe Y, Doi T, et al. Delayed laparoscopic subtotal cholecystectomy in acute cholecystitis with severe fibrotic adhesions. *Sug. Endosc*. 2008; 22(12): p2720-2723. <https://doi.org/10.1007/s00464-008-9879-y>
- [29] Reynolds W Jr. The first laparoscopic cholecystectomy. *JSLs*. 2001; 5(1): p89-94. PMID: 11304004; PMCID: PMC3015420.
- [30] Henneman D, do Costa DW, Vrouenracts BC, Van Wagenveld BA, Lagarde SM. Laparoscopic partial cholecystectomy for the difficult gallbladder: a systematic review *Surg. Endosc*. 2003; 17(9): p1437-1439.
- [31] Crosthwaite G, McKay C, Anderson JR. Laparoscopic subtotal cholecystectomy. *JR Coll Surg. Edinb*. 1995; 40(1): p20-21. PMID: 7738890.
- [32] Hubert C, Annet L, Van Beers BE, Gigot JF. The 'inside approach of the gallbladder' is an alternative to the classic calot's triangle dissection for a operation in severe cholecystitis. *Surg. Endosc*. 2010; 24(10): p2626-2632. <https://doi.org/10.1007/s00464-010-0966-5>
- [33] Michalowski K, Bornmann PC, Krige JE, Gallagher PJ, Treblanche J. Laparoscopic Subtotal cholecystectomy in patients with complicated acute cholecystitis or fibrosis – *J. Surg*. 1998; 85(7): p904-906. <https://doi.org/10.1046/j.1365-2168.1998.00749.x>
- [34] Carter DC, Patterson-Brown S. Cholecystectomy, cholecystostomy and exploration of bile duct. In: Carter DC, Russell RCG, Pit HA, Bismuth, eds. *Rob & Smith's Operative Surgery: Hepatobiliary and Pancreatic Surgery*; London: Chapman & Hall 1996: p337-50.
- [35] King NKK, Priyantha Siriwardana HP, Siriwardana AK. Cholecystitis after cholecystectomy. *JR Soc Med*. 2002 Mar; 95(3): p138-139. <https://doi.org/10.1177/014107680209500311>
- [36] Ros E, Zambon D. Post cholecystectomy symptoms. A prospective study of gallstone patients before and two years after surgery. *Gut* 1987; 28: p1500-4. <https://doi.org/10.1136/gut.28.11.1500>
- [37] Bates T, Ebbs SR, Harrison M, A¹ Hern RP. Influence of cholecystectomy on symptoms. *Br J Surg* 1991; 78: p964-7.
- [38] Wakabayashi G, Iwashita Y, Hibi T, et al. Tokyo Guidelines 2018: surgical management of acute cholecystitis: safe steps in laparoscopic cholecystectomy for acute cholecystitis. *J Hepatobiliary Pancreat Sci*. 2018; 25: p73-86. <https://doi.org/10.1002/jhbp.517>
- [39] Kogha A, Suzuki K, O Komura T, Yamashita K, Isogaki J, Kawabe A, Kimura T. Calculus left in remnant gallbladder cause long-term complications in patients undergoing subtotal cholecystectomy. *HPB* 2019; 21: p508-14.

- [40] C Palanivelu, M. Rangrajan, PA Jategaonkar, MV Madan Kumar, NV Anand. Laparoscopic management of remnant cystic duct calculi: a retrospective study. *Ann R Coll. Surg. Engl.*, 2009 Jan; 91(1): p25-29.
<https://doi.org/10.1308/003588409X358980>
- [41] P. Chowbey, V. Soni, A. Sharma, R. Khullar, M Baijal. Residual gall stone disease – Laparoscopic management. *Ind J Surg.*, 2010 Jun; 72(3): p220-225.
<https://doi.org/10.1007/s12262-010-0058-8>
- [42] Hamida WB, Jerraya H, Nasseh S, Haloui N, Khalfallan M, Nourea M. The complications of subtotal cholecystectomy: A case report: *Int J Surg Case Rep.* 2021; 83: 105950.
<https://doi.org/10.1016/j.ijscr.2021.105950> Epub 2021 Apr 30
- [43] Strasberg SM, Pucchi MJ, Dezeil, Burnt LM. Subtotal cholecystectomy ‘fenestrating’ vs ‘reconstituting’ subtypes and the prevention of bile duct injury: definitions of the optimal procedure in difficult operative conditions. *J Am Coll Surg.* 2016; 222(1): p89-96.
<https://doi.org/10.1016/j.jamcollsurg.2015.09.019>
- [44] Raimandas Lunevicius, Saburo Matsubara. Review Literature on Partial Resections of the Gall Bladder, 1898-2022: The Outline of the Conception of Subtotal Cholecystectomy and a suggestion of Use the Terms ‘Subtotal Open-Tract Cholecystectomy’ and ‘Subtotal Closed-Tract Cholecystectomy’. *J Clin Med.* 2023 Feb 3; 12(3): p1230.
<https://doi.org/10.3390/jcm12031230>
- [45] H. Demetriades, MG Pramate Fkakis, I Kanellos, S Angelopoulos, I Mantzoros, D Betsis. Retained Gallbladder Remnant After Laparoscopic Cholecystectomy. *J Laparoendoscopic & Advanced Surgical Techniques.* 2008 April 1; 18(2): p276-279.
<https://doi.org/10.1089/lap.2006.0210>
- [46] Madding GF. Subtotal cholecystectomy in acute cholecystitis. *Am J Surg.* 1955; 89(3): p604-607.
[https://doi.org/10.1016/0002-9610\(55\)90108-2](https://doi.org/10.1016/0002-9610(55)90108-2)
- [47] Strasberg SM. A three-step conceptual roadmap for avoiding bile and injury in laparoscopic cholecystectomy: an invited perspective review. *J Hepatobiliary Pancreat Sci* (2019) 26(4): p123-7. <https://doi.org/10.1002/jhbp.616>
- [48] Ming W, Ying T, Toh J, Shelat VG, Wei C, Sameer H, et al. Subtotal cholecystectomy: early and long-term outcomes. *Surg. Endosc* 2020; 34: p4536-42.
<https://doi.org/10.1007/s00464-019-07242-7>
- [49] Tang A, Cohan CM, Beattie G, Mooney CM, Chiang A, Keiley JA. Factors that predict the need for subtotal cholecystectomy. *Am Surg.* 2021; 87(8): p1245-51. <https://doi.org/10.1177/0003134820979783>
- [50] Toro A, Teodoro M, Khan M, Schembari E, Di Saverio S, Catena F, et al. Subtotal cholecystectomy for difficult acute cholecystitis: how to finalize safety by laparoscopy – a systematic review. *World J Emerg Surg.* 2021; 16(1): p45.
<https://doi.org/10.1186/s13017-021-00392-x>
- [51] Boyd K, Bradley NA, Cannings E, Shearer C, Wadhwan H, Wilson MSJ, et al. Laparoscopic subtotal cholecystectomy; change in practice over a 10-year period. *HPB* 2022; 24(5): p759-63. <https://doi.org/10.1016/j.hpb.2021.10.003>
- [52] Chavez-villa M, Dominguez-rosando I. Subtotal Cholecystectomy after failed critical view of safety is an effective and safe bail out surgery. *J. Gastrointest Surg.* 2021; 25: p2553-61.
<https://doi.org/10.1007/s11605-021-04934-1>
- [53] Camilo Ramirez-Giraldo, Andres Torres-Gullar, and Isabella Van-Londono. State of the art in subtotal cholecystectomy: An overview. *Front Surg.* 2023 Apr 21; 10: 1142579.
<https://doi.org/10.3389/fsurg.2023.1142579>
- [54] Schein M, Rogers PN, Assalia A, Lane R. Schein’s Common Sense Emergency Abdominal surgery. Springer 2010; 3: p192.
- [55] Di Cataldo A, Avogadro GV, Cannizzaro PD, Latino R. Subtotal Cholecystectomy for difficult gall bladder: a brilliant solution or a lesser skill in biliary surgery? *Surgery* (2021); 170(3): p989.
<https://doi.org/10.1016/j.surg.2021.03.038>
- [56] Flum DR, Cheadle A, Prela C, et al. Bile duct injury during cholecystectomy and survival in medicare beneficiaries. *JAMA* 2003; 290: p2168-2173.
<https://doi.org/10.1001/jama.290.16.2168>
- [57] Savader SJ, Lillemoe KD, Prescott CA, et al. Laparoscopic cholecystectomy related bile duct injuries: a health and financial disaster. *Ann Surg* 1997; 225: p268-273.
<https://doi.org/10.1097/0000658-199703000-00005>
- [58] Moossa AR, Mayer AD, Stabile B. Iatrogenic injury to the bile duct who, how, where? *Arch Surg.* 1990; 125: p1028-1030.
<https://doi.org/10.1001/archsurg.1990.01410200092014>
- [59] Salky BA, Edye MB. The difficult Cholecystectomy: problems related to concomitant diseases. *Semin Laparosc Surg.* 1998; 5(2): p107-114.
<https://doi.org/10.1177/155335069800500205>
- [60] Laws HL. The difficult cholecystectomy problems during dissection and extraction *Semin Laparosc Surg.* 1998; 5(2): p81-91.
<https://doi.org/10.1177/155335069800500203>
- [61] Kehr H. Introduction to the Differentiated Diagnosis of the Separate forms of Gallstone Disease: Based upon His Own Experiences Gained in 433 Laparotomies for Gallstones. P Blakiston’s Son & Co.; Philadelphia, PA, USA: 1901, p370.
- [62] Kehr H. Die Praxis der gallenwege. *Chirur in Wort und Bild;* 1913, 1080P.
<https://doi.org/10.1007/978-3-642-96565-4>
- [63] Zhu J, Zhang Z. Laparoscopic remnant cholecystectomy and transcystic common bile duct exploration for gallbladder cystic duct remnant with stones around and choledocholithiasis after cholecystectomy. *J. Laparoendo SC Adv. Surg. Tech.* 2015; 25: p7-11.
<https://doi.org/10.1089/lap.2014.0186>
- [64] Johnston WR, Flower KJ, Williams GA, Grossman JG, Hammill CW, Hawkins WG, A Diagnosis Reconsidered: The Symptomatic Gallbladder Remnant. *J Hepatobiliary Pancreatic Sci.* 2019 Apr; 26(4): p137-143.
<https://doi.org/10.1002/jhbp.613>

- [65] LM Brunt, DJ Deziel, DA Telem, et al Safe cholecystectomy multi-society practice guideline and stratus-of-the-art consensus on prevention of bile duct injury during cholecystectomy. *Surg. Endosc*, 2020; 34: p2827-2855. <https://doi.org/10.1007/s00464-020-07568-7>
- [66] A Seshadri, AB Peitzman. The difficult cholecystectomy: What you need to know. *J Trauma Acute Care Surg*, 2024; 97: p325-336. <https://doi.org/10.1097/TA.0000000000004337>
- [67] Flum DR, Dellinger EP, Cheadle A, Chan L, Koepsell T. Intraoperative Cholangiography and risk of common bile duct injury during cholecystectomy. *JAMA* 2003; 289: p1639-44. <https://doi.org/10.1001/jama.289.13.1639>
- [68] M Al-Azzawi, M Abouelazyem, C Parmar, R Singhal, B Amar, A Martinino, S D Atici, K Mahawar. A systematic review on laparoscopic subtotal cholecystectomy for difficult gallbladder: a lifesaving bailout or an incomplete operation? *Ann R Coll Surg Engl*. 2024 Mar; 106(3): 205-212. <https://doi.org/10.1308/rcsann.2023.0008>
- [69] Hussain M, Nagral. Biliary pancreatitis secondary to stone from gallbladder remnant. *Tropical Gastroenterology* 2010; 31: p230-233. <http://dx.doi.org/21560535>
- [70] S H Ryou, HJ Kim. Successful removal of remnant cystic duct stump stone using single operator cholangioscopy – guided electrohydraulic therapy: two case reports *Clin Endosc*, 2023; 56(3): p375-380. <https://doi.org/10.5946/ce.2021.273>
- [71] Jebakumar GS, Muthiah J, Jayapal L, Kumar RS, Tasgaon Kar S, Anand KSS, Jamed JKA, Swain SK, Raghunath KJ, Reddy PK, Balachandar TG. Laparoscopic management of remnant gall bladder with stones: Lesson from a tertiary care centre's experience. *Laparoscopic, Endoscopic and Robotic Level I, II or III Subtotal Cholecystectomy Surgery*. 2024; 7(1): p27-33. <https://doi.org/10.1016/j.lers.2024.02.004>
- [72] Chowbey PK, Bandyopadhyay SK, Sharma A, Khullar R, Soni V, Baijal M. Laparoscopic reintervention for residual gallstone disease, *Surgical Laparoscopy, Endoscopy and Percutaneous Techniques* 2003; 13(1): p31-35. <https://doi.org/10.1097/00129689-200302000-00007>
- [73] Samir O Cawich, Carlos Wilson, Lindberg K Simpson, Akil J Baker. Stump Cholecystitis: Laparoscopic Completion cholecystectomy with basic laparoscopic equipment in a resource. Poor Setting *Case Reports in Medicare* 2014; 1: 1787631. <https://doi.org/10.1155/2014/787631>. Epub 2014 Aug 21.