Journal of Surgery
Singh R, et al. J Surg 11: 11672
www.doi.org/10.29011/2575-9760.11672
www.gavinpublishers.com
Original Article

Implementation of Critical View of Safety During Laparoscopic Cholecystectomy: A Prospective Analysis of 171 Patients

Ranbir Singh[1*], Ravinder S. Thind[2], Chitra Kumari[1], Adarsh Narayan Yadav[1], Devyank Jain[1], Avinash R. Desai[1], Suryansh Chauhan[1], Nitish Madaan[1], Aeshwarye Agarwaal[3], Kuldip Singh[4]

[1]Section of General, Minimally invasive and Advanced Laparoscopic surgery,Department of Surgery, Mohandai Oswal Hospital, Ludhiana

[2]Department of General Surgery , Christian Medical College and Hospital , Ludhiana

[3]Department of Anesthesia and Critical Care, Mohandai Oswal Hospital, Ludhiana

[4]Department of Laparoscopic Surgery ,Ludhiana Laparoscopic and Surgical clinic, Ludhiana

***Corresponding Author:** Ranbir Singh, Department of Surgery, Section – General, Minimally invasive and Advanced Laparoscopic surgery, Mohandai Oswal Hospital, Ludhiana

Citation: Singh R, Thind RS, Kumari C, Yadav AN, Jain D, et al. (2026) Implementation of Critical View of Safety During Laparoscopic Cholecystectomy: A Prospective Analysis of 171 Patients. J Surg 11: 11672 DOI: 10.29011/2575-9760.011672

Received Date: 05 February 2026; **Accepted Date:** 04 August 2026; **Published Date:** 07 August 2026

Abstract

Background: The Critical View of Safety (CVS) is the globally endorsed method for preventing Bile Duct Injury (BDI) during Laparoscopic Cholecystectomy (LC). However, its reliable attainment varies widely in real-world surgical practice.

Objective: To evaluate the feasibility, efficacy and safety of CVS in a prospective cohort of 171 patients and to identify factors limiting its attainment.

Methods: A prospective observational study was performed at Mohandai Oswal Hospital, Ludhiana , on 171 patients for a duration of 2 yrs (2023-2025) .Intraoperative doublet photographs documenting CVS were independently evaluated by three expert surgeons.Associations between CVS scores and surgical difficulty, anatomical variations, intraoperative and postoperative complications were analysed.

Results: CVS score of 6/6 was achieved in 83.63% of cases. Dense adhesions ($p < 0.001$), aberrant anatomy ($p < 0.001$), and frozen hepatocystic triangle significantly reduced CVS attainment. Intraoperative complications, including bleeding (11.7%) and bile spillage (4.68%), were significantly more common when CVS ≤4. One patient (0.58%) experienced a lateral BDI (Strasberg Type D), correlating with CVS score 3. Lower CVS scores predicted greater postoperative pain, ileus, and prolonged hospitalization (all $p < 0.001$).

Conclusion: CVS is highly effective for ensuring safe laparoscopic cholecystectomy. Failure to achieve CVS strongly correlates with operative difficulty and increased complications. Surgeons must adopt bailout strategies when CVS cannot be attained safely.

Keywords: Bile Duct Injury (BDI); Critical View of Safety (CVS); Laparoscopic Cholecystectctomy (LC)

Introduction

Laparoscopic Cholecystectomy (LC), first performed by Mühe in 1985, revolutionized gallstone surgery by reducing morbidity, hospital stay, and recovery time [1]. LC is considered as the gold standard treatment for symptomatic gallstones disease, supported by NIH consensus [2]. However, BDI (Bile duct injurie) remain more common in LC than in open procedures, often resulting from misperception rather than technical incompetence [3]. Prof. Strasberg in 1995 , coined an approach of surgical dissection to way forward for a reliable method for ductal identification , based on fundus first technique of open cholecystectomy i.e. termed as Critical View of Safety (CVS) [4] .It has 3 attributes;

1. Clearance of fat and fibrous tissue from hepatocystic triangle.

2. Visualization of only two structures – cystic duct and cystic artery entering the gallbladder.

3. Lifting of lower one-third of gallbladder from the liver bed to expose the cystic plate.

Despite widespread endorsement, studies show that surgeons often believe they have achieved CVS even when objective review reveals incomplete dissection [5]. Anatomical variations, inflammation, adhesions, fibrosis, and difficult hepatocystic triangle's anatomy are major barriers to achieving CVS [6-13]. Bailout strategies including laparoscopic subtotal cholecystectomy (Reconstituting and Fenestrating) or conversion to open are recommended when CVS is unsafe to pursue [14]. Adjunctive techniques such as Intraoperative Cholangiography (IOC), laparoscopic ultrasound, fluorescence imaging with Indocyanine Green (ICG) and emerging artificial intelligence assisted navigation tools can be used in difficult cases. This study evaluates the feasibility and efficacy of CVS in a real-world cohort of 171 LC cases and analyses its relationship to complications and anatomical challenges.

Materials and Methods

The study was carried out from January 2023 to December 2025 at Mohandai Oswal Hospital, Ludhiana. 171 patients between 18-80 yrs with ASA score of III or less than III were part of the study. The hospital review board approved the study. All patients diagnosed with Acute/chronic calculous cholecystitis, GB Mucocele, GB empyema, perforated gallbladder, Gallstone pancreatitis were included in the study. Patients of age less than 18 yrs and with terminal illness were not a part of the study. Method of Assessing CVS: Intraoperatively ,before clipping the cystic duct and cystic artery , a doublet photograph(as shown in Figure 1) was taken for assessment of the 3 points of critical view of safety .All the pictures were sent randomly to 3 different experts from different institutions ,who have performed more than 10,000 laparoscopic cholecystectomies and are well versed with CVS attributes , for scoring (according to the six point strategy mentioned below) (Tables 1,2).

Six Point Strategy

6 points distribution	Points assigned
Two structures entering into GB, cystic duct and cystic artery exposed	2
Calot's triangle cleared of fat and fibrous tissue	2
1/3rd of cholecystic plate cleared	2

Table 1: A six point strategy is devised on the basis of 3 attributes of critical view of safety.

GRADES	SCORE
Unsafe	2/6
Equivocal	4/6
Safe	6/6

Table 2: Grading according to the scores (based on 6 point strategy).

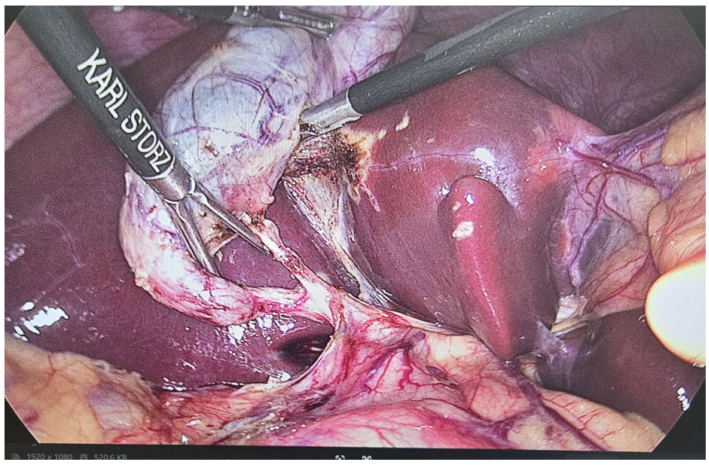


Figure 1: Doublet View Picture of Critical View of Safety(Taken Intraoperatively Before Clipping Cystic Duct And Cystic Artery)

Post surgery all the patients were given USG guided right sided Sub Costal Transversus Abdominins Plane block by Senior Resident supervised by a senior consultant. Patients were monitored postoperatively for hospital stay, pain ,nausea, vomiting ,oral intake, prolonged ileus ,bleeding and other complications. The efficacy of the CVS is assessed on the basis of intraoperative and postoperative complications.

Results and Analysis

The association between the Critical View of Safety (CVS) score and various intraoperative, postoperative, and anatomical factors was assessed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant. Graphical representations, including bar charts and pie charts, were used to visualize the distribution of patient demographics, clinical findings, surgical outcomes, and the associations between key variables. In a sample size of 171 patients 59.04% were females and 40.96% were males, which shows female preponderance of the disease. Mean age of patients : 47.92 ± 13.70 Figure 2.

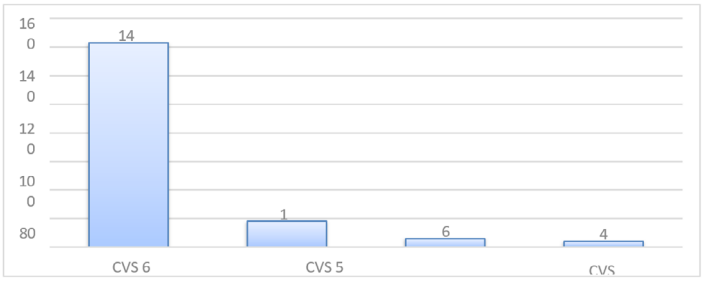


Figure 2: Distribution of Patients According to CVS Score.

Preoperative Diagnosis: In our study ,most of the patients presented to us with acute cholecystitis (50.55%) ,on outpatient basis and were planned for elective laparoscopic cholecystectomy, within 72hrs of presentation. The distribution of patients based on the type of admission showed that 155 patients (90.64%) were admitted electively, while 16 patients (9.36%) required emergency admission (Table 3).

Diagnosis	Frequency (%)
Acute cholecystitis	50.88%
Chronic cholecystitis	26.32%
Others (mucocele, empyema, polyp, etc.)	22.8

Anatomical variations	**No of Patients**
No anatomical variation	149 (87.13%)
Aberrant Anatomy	18 (10.53%)
Frozen hepatocystic triangle	3 (1.75%)
Situs Inversus Partialis	1 (0.58%)

Table 3: Distribution of patients according to Anatomical Variations.

Maximum number of patients i.e. 149 out of 171 had no anatomical variations, where as 22 patients had variable anatomy. Out of which 1 patient had situs inversus partialis (Table 4).

Adhesion Grade	No of Patients
Minimal	68 (39.77%)
None	61 (35.67%)
Dense	42 (24.56%)

Table 4: Distribution of Patients According to Adhesion Grade.

The distribution of adhesion grades showed that 68 patients out of 171 had minimal adhesions, while 61 patients had no adhesions and dense adhesions were observed in 42 patients .Intraoperatively it was found that 124 patients (72.51%) had a normal gallbladder, 20 patients (11.70%) had a distended gallbladder, 15 patients (8.77%) had contracted gallbladder, 9 patients (5.26%) had mucocele, and 3 patients (1.75%) had perforated gallbladder. In 143 patients (83.63%) we could achieve a CVS score of 6, while in 18 patients (10.53%) we could achieve a score of 5. A score of 4 was achieved in 6 patients (3.51%), and in 4 patients we could only achieve a score of 3 (Table 5).

Intraoperative Complications	No of Patients
None	141 (82.46%)
Bleeding	20 (11.70%)
Bile spillage	8 (4.68%)
Stone spillage	1 (0.58%)
Bile Duct Injury	1 (0.58%)

Table 5: Distribution of Patients According to Intraoperative Complications.

In 141 patients (82.46%) there were no intraoperative complications, 20 patients (11.70%) had bleeding, 8 patients (4.68%) had bile spillage, 1 patient (0.58%) had stone spillage, and 1 patient (0.58%) suffered bile duct injury.Postoperative period was uneventful for 133 patients (77.78%) and they had no complications, while 25 patients (14.62%) experienced excess pain. Prolonged ileus was observed in 13 patients (7.60%). For 157 patients (91.81%) a jackson pratt drain was kept in situ, while for 14 patients (8.19%) no drain was put. Majority of patients (160 out of 171) were discharged on postop day 1, while 11 patients were discharged on postop day 2 (Table 6).

Intraoperative Complications	CVS Score (out of 6)				p-Value
	CVS 6	CVS 5	CVS 4	CVS 3	
None	128(89.51%)	12(66.67%)	1 (0.00%)	0 (0.00%)	**<0.001**
Bile spillage	4 (2.80%)	1 (5.56%)	2 (33.33%)	1 (25.00%)	
Bleeding	10 (6.99%)	5 (27.78%)	3 (50.00%)	2 (50.00%)	
Stone spillage	1 (0.70%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Bile Duct Injury	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (25.00%)	

Table 6: Association Between Intraoperative Complications and CVS Score.

The association between intraoperative complications and CVS scores showed that among patients with CVS score of 6, 128 had no complications ,4 patients had bile spillage ,10 patients had intraoperative bleeding and only 1 had bile spillage.1 patient with CVS score of 3 had bile duct injury . There was a statistically significant association between intraoperative complications and CVS scores ($p < 0.001$, chi-square test) (Table 7).

Postoperative Complications	CVS Score (out of 6)				p-Value
	CVS 6	CVS 5	CVS 4	CVS 3	
No complications	122	11 (61.11%)	0 (0.00%)	0 (0.00%)	**<0.001**
Prolonged ileus	6 (4.20%)	2 (11.11%)	3 (50.00%)	2 (50.00%)	
Excess pain	15 (10.49%)	5 (27.78%)	3 (50.00%)	2 (50.00%)	

Table 7: Association Between Postoperative Complications and CVS Score.

Almost all patients with a CVS score of 3 and 4 were found to have some sort of postoperative complications whereas patients with CVS scores of 5 or 6 had comparatively fewer postoperative complications. There was a statistically significant association between postoperative complications and CVS scores ($p < 0.001$, by chi- square test) (Table 8).

	CVS Score (out of 6)				p-Value
Anatomical variations	CVS 6	CVS 5	CVS 4	CVS 3	
No anatomical variations	126 (88.11%)	17 (94.44%)	4 (66.67%)	2 (50.00%)	**<0.001**
Situs inversus partialis	1 (0.70%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Aberrant anatomy	16 (11.91%)	1 (5.56%)	1 (16.67%)	0 (0.00%)	
Calot's triangle obliterated	0 (0.00%)	0 (0.00%)	1 (16.67%)	2 (50.00%)	

Table 8: Association Between Anatomical Variations and CVS Score.

It was easier to achieve a CVS score of 5 or 6 in patients with no anatomical variations, where as in patients with obliterated hepatocystic triangle ,only a CVS score of 3 or 4 could be achieved (Table 9).

	CVS Score (out of 6)				p- Value
Adhesion Grade	CVS 6	CVS 5	CVS 4	CVS 3	
Minimal	67 (46.85%)	1 (5.56%)	0 (0.00%)	0 (0.00%)	<0.001
None	57(39.86%)	4 (22.22%)	0 (0.00%)	0 (0.00%)	
Dense	19 (13.29%)	13(72.22%)	6 (100.00%)	4 (100.00%)	

Table 9: Association Between Adhesion Grade and CVS Score.

In patients with minimal adhesions, 67 had a CVS score of 6, 1 had a score of 5, and none had a score of 4 or 3. Achieving a CVS score of 5 or 6 was difficult in patients with dense adhesions, 10 patients with dense adhesions had a CVS score of 3 or 4.

Discussion

The present study evaluated the attainment of the Critical View of Safety (CVS) during laparoscopic cholecystectomy and examined its relationship with anatomical variations, adhesion grades, intraoperative difficulty, postoperative outcomes, and overall surgical safety. The findings demonstrate a strong association between optimal CVS scores and improved surgical outcomes, reinforcing its role as a vital safeguard against bile duct injuries. These results are consistent with internationally accepted recommendations, including SAGES and the Tokyo Guidelines, which emphasize achieving CVS before transection of any structures in the hepatocystic triangle [15,16]. In this study, the demographic profile reflected the typical epidemiology of gallstone disease, with a mean age of 47.92 ± 13.70 years and a female predominance of 59.04%. This aligns with global data demonstrating a higher prevalence of gallstone disease among women in the fourth to sixth decades of life [12]. Acute calculous cholecystitis accounted for more than half of the cases, signifying its continued prominence as the most frequent indication for emergency and elective cholecystectomy. Anatomical variations were present in 12.8% of patients, with aberrant vascular anatomy accounting for the majority.

In most of these patients we encountered calot's artery and posterior branch of cystic artery during dissection of hepatocystic triangle. The presence of frozen hepatocystic triangle or severe inflammation significantly lowered the CVS score. These patients predominantly achieved CVS scores of 3 or 4, indicating suboptimal visualization. This statistically significant association ($p < 0.001$) highlights the challenges posed by distorted anatomy. Multiple studies have similarly reported that anatomical aberrations and severe inflammation are major contributors to bile duct injuries and operative difficulty, especially when CVS cannot be fully achieved [6-13]. In our study we also encountered a rare case of Situs Inversus Partialis, where GB was present on left side instead of right side (Figures 3,4). Inspite of being a technically challenging surgery CVS score of 5 was achieved by just changing the position of surgeon from American to French technique and ports put maintaining the ergonomics. Pahwa HS et.al. in 2012 reported a similar case of situs inversus , in which laparoscopic cholecystectomy was performed by modifying the operative technique and adopting a mirror image of usual port placement on left side [17].

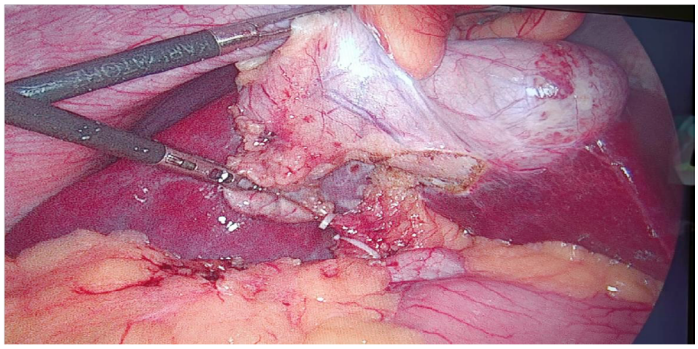


Figure 3: Situs inversus partialis.

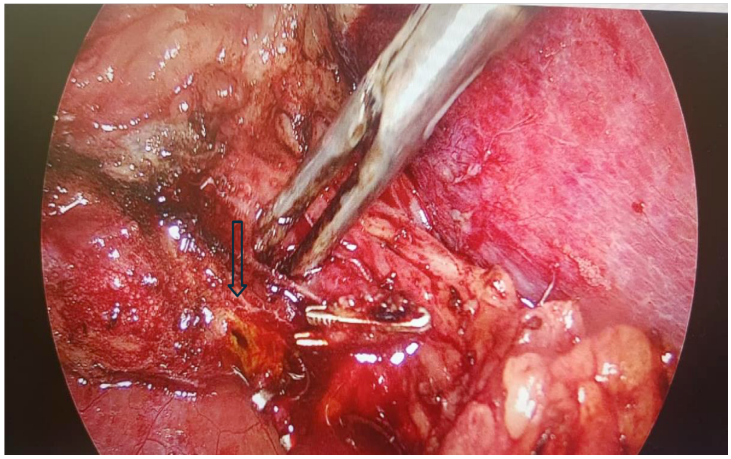


Figure 4: Intraoperative picture showing lateral bile duct injury.

Adhesions were another major determinant of operative difficulty in this study. Patients with minimal or no adhesions overwhelmingly achieved CVS scores of 6, whereas dense adhesions with frozen hepatocystic triangle markedly reduced CVS attainment. Most the patients with dense adhesions had CVS scores of 3 or 4, demonstrating a strong correlation ($p < 0.001$). These findings are in accordance with evidence showing that chronic inflammation, scarring, and fibrosis obscure the hepatocystic triangle, increasing the risk of misidentification of biliary structures [6-13]. Intraoperative complications were significantly more frequent among patients with lower CVS scores. Bleeding and bile spillage occurred predominantly in patients with CVS scores ≤ 4 ($p < 0.001$). Conversely, patients in which we achieved CVS 6 had the lowest rates of complications. Although few cases of bile spillage were reported while dissecting gall bladder from cystic plate in patients with CVS score of 6 also ,due to acute inflammation , thinning of GB wall due to GB gangrene or empyema and rarely due to thermal injury by cautery devices .These conditions make GB wall friable and more prone to injury and bile spillage. To the contrary in patients with CVS 3 or 4, aberrant vascular anatomy

like; Accessory/ Aberrant right hepatic artery, double cystic artery and biliary variations like ; Aberrant right posterior sectoral duct directly draining into cystic duct, aberrant RHD directly opening into CBD ,lead to misidentification of cystic duct and cystic artery causing bleeding and bile spillage.

The findings of our study are in coherence with the study done by Way et al. analysed BDIs that occurred from laparoscopic cholecystectomies and found that the primary cause of error in 97% of cases was one of visual perception/illusion rather than surgical skill and knowledge. The phenomenon of misperception in such cases is termed cognitive fixation. Misidentification of the common duct (or RHD) for the cystic duct was the mistake observed, which resulted in partial injury or transection of the misidentified duct. This finding suggests that the laparoscopic environment may predispose to misperception whether due to loss of haptic information, loss of depth perception, or limitations in perspective (position of laparoscope is fixed) [4]. In our study 1 out of 171 patients (0.005%) with CVS score of 3 , was reported with a lateral Bile duct injury (Type D ,according to Strasberg's classification of bile duct injury), identified intraoperatively and primary repair of the rent was done ,followed by laparoscopic subtotal cholecystectomy (due to short / absent / fused cystic duct with CBD) and postoperative ERCP stenting [3]. Ali AMA et .al. did a Prospective randomized clinical study in 2018 (three timing groups: early / intermediate / late) on 40 patients with post cholecystectomy BDIs. In these patients surgical repairs were done ,according to timing and injury severity .Primary repair or end-to-end anastomosis was done for some early (simpler) injuries ,for more complex cases reconstructions ,e.g., biliodigestive anastomoses/ hepaticojejunostomy were done. [18] The incidence of bile duct injury (0.005%) in our study is much less in comparison to study done by Kambakamba P. et al. in 2022, where a total of 15,609 patients were screened intraoperatively for BDIs . Out of which 5,229 BDIs (0.033%) were reported. They were managed by immediate/early/delayed/late repairs and a mix of endoscopic / interventional radiology measures for leaks/obstruction and surgical reconstructions (Roux-en-Y hepaticojejunostomy, biliodigestive anastomosis) for major injuries. [5]

Studies suggest ,if the hepatocystic triangle cannot be safely dissected ,laparoscopic subtotal cholecystectomy - Fenestrating / Reconstituting should be considered . In the reconstituting approach, the neck of the gallbladder is sutured or stapled off (as shown in Figure 4) .At our centre we prefer reconstituting technique over fenestrating type. Van Dijk and colleagues did a study on outcomes of laparoscopic subtotal cholecystectomy in 191 patients in four teaching hospitals in the Netherlands . Of these, 53% had a fenestrating subtotal cholecystectomy and 38% had a reconstituting subtotal cholecystectomy. Among these cases bile leak was observed in 18% of the fenestrating cases and 7% of the reconstituting cases and biliary stone recurrence was seen in 9% of the fenestrating cases and 18% of the reconstituting cases. In contrary to this,no incidence of recurrent biliary stone were reported, since intraoperatively very small stump was left behind and it was plicated completely such that no space is left for stone formation. All these patients were followed up every 6 months on outpatient basis with LFT and ultrasonography abdomen. These data suggest that laparoscopic subtotal cholecystectomy is an acceptable alternative in patients where CVS cannot be achieved [19,14,20].

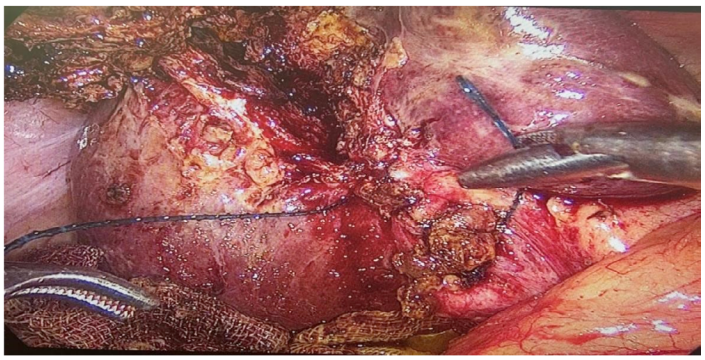


Figure 3: Subtotal cholecystectomy (Reconstituting Approach).

Contrary to our study where , none of the cases were converted to open ,a second option in the difficult gallbladder when the CVS cannot be obtained is to convert to an open cholecystectomy. Traditionally, this has been the preferred approach if progress is not being made and the laparoscopic dissection is too difficult. However, many surgeons today have been trained in an era where they received limited experience with open cholecystectomy and, therefore, may not have the appropriate experience to manage a difficult gallbladder in an open fashion. In addition, conversion to an open operation does not necessarily protect against biliary injury. [4]

Recently, infrared cholangiography with indocyanine green has been advocated as an alternative means for imaging the biliary tree during cholecystectomy . This is also performed in our centre and was used in few of the complicated cases. The advantage of this approach is that it allows continuous biliary mapping in which one can shift their gaze back and forth between white light and fluorescence imaging to visualize the bile duct and/or cystic duct. The limitations of this technology are that it has not been widely studied nor has it been evaluated sufficiently under many conditions of difficult cholecystectomy such as impacted stone and in obese patients. [21] Postoperative morbidity, including severe pain and prolonged ileus, also followed a similar pattern, with higher complication rates observed in patients with lower scores ($p < 0.001$).

Pain was assessed on the basis of VAS(Visual analog scale) score. The score ranges from 1-10 based on the severity of pain. For management of pain multimodal analgesia and other approaches were used including TAPP (Transabdominal pre-peritoneal) block. Patient were discharged after satisfactory pain relief, on oral analgesics. Whereas ,for prolonged ileus bowel stimulants (suppository) were given. Along with it ,ERAS (Enhanced Recovery After Surgery) Protocol of early mobilization, early drain out and early initiation of oral feeds were followed. These observations reinforce the principle that achieving the CVS is directly linked to safer dissection, reduced complications, and smoother postoperative recovery, Similar to the findings of study done by Mushtaque et.al in 2019 ,which shows that in difficult laparoscopic cholecystectomies prolonged OR time correlate with higher postoperative pain and higher analgesic requirement. All patients were assessed for postoperative pain on the basis of VAS score and patients with difficult laparoscopic cholecystectomies required additional doses of analgesics and opioids [22].

Strasberg et.al says a CVS score of 5 also warranties safety, if achieving CVS score 6/6 is difficult because of non-lifting of 1/3rd of cystic plate , then 1cm of GB lifting from cystic plate is enough and cystic artery is clipped, sacrificed first to ensure one and only structure seen entering the gall bladder i.e. cystic duct , which gives surity and prevents bile duct injury (just like a visual cholangiography).[3] Hospital stay duration was also significantly linked to CVS scores. Most patients with CVS 6 were discharged on post-op day2 , while prolonged hospital stay was more common in patients with lower scores ($p < 0.001$). This reflects the broader impact of inadequate CVS on postoperative recovery and resource utilization .In a study done by Kwon AH et.al similarly noted increased hospitalization duration among patients experiencing intraoperative difficulty or postoperative complications. [23] The incidence of biliary injuries has not declined significantly in the past decade despite many strategies to reduce these complications. One reason for this may be that although CVS is recommended, it is often not attained and is misunderstood. Secondly, only one or two of the three CVS criteria may be met and the surgeon terms it as the critical view of safety. Nijssen et.al. did a study on 1108 patients, in which it was quoted that in 80% of the patients CVS was achieved intraoperatively (as mentioned in OT notes) but actual percentage of patients in which CVS was achieved was only 10.8%. [24] If the CVS is achieved satisfactorily, it should ensure almost 100% safety from misidentification of the cystic duct from the CBD, CHD and RHD. Sanjay et al. in a study ,found that 82% of the British and Irish upper gastrointestinal (GI) surgeons advocated CVS, [15] However what is not known is how many surgeons actually practice this properly. The reasons observed for its lack of adoption are threefold:

i. Achieving CVS is somewhat difficult and time consuming, as it involves more dissection before clipping or cutting the cystic artery and duct. On the contrary , in our institute ,the chief surgeon who advocates and performs around 300-400 laparoscopic cholecystectomies per year believes that extensive dissection of hepatocystic triangle is important and time is not a criteria.

ii. An incomplete understanding of what the Critcal view of safety is.

iii. Comfort with the infundibular technique which is comparatively easier and quick to achieve and works well in majority of patients , but is an error trap in acute situation. It makes a false funnel view , which gives a visual deception to the surgeon thinking the cystic duct to be CBD/CHD.

Lam et.al. did one of the earliest prospective study on 100 patients in 2014, where a doublet picture of each patient was taken intra-operatively. Each photograph was sent to 3 different surgeons for assessment. It was found that frequent discrepancies existed; In many cases the surgeon declared as “CVS obtained” did not meet true CVS criteria on photo review. Interobserver reliability was moderate, showing variability in how surgeons interpret CVS. Surgeons tended to overestimate the completeness of their dissection .In contrary to this ,in our study pictures taken intraoperatively were sent randomly to three different surgeons and it was inferred that in most of the cases ,where we did complete dissection and achieved a CVS score of 6 intraoperatively ,were also given full scores by assessors on the basis of doublet photo documentation. [25] Overall, this study provides strong evidence that achieving a CVS score of 6 correlates with fewer complications, reduced operative difficulty, safer dissection, and faster postoperative recovery. The statistically significant relationships observed across anatomical variations, adhesion severity, complication rates, and safety classification validate CVS as an indispensable component of safe laparoscopic cholecystectomy. Consistent training, adherence to technique, and regular auditing of CVS performance are crucial steps toward preventing bile duct injuries, which remain among the most serious complications of gallbladder surgery.

Summary and Conclusion

The findings of this study reaffirm that achieving an optimal Critical View of Safety (CVS) is strongly associated with improved intraoperative clarity, reduced complication rates, and enhanced postoperative recovery in laparoscopic cholecystectomy. A CVS score of 6 was attainable in the vast majority of patients, highlighting the feasibility of consistently applying this safety standard in routine surgical practice. Anatomical variations and dense adhesions emerged as significant predictors of lower CVS scores, emphasizing the need for heightened vigilance, meticulous

dissection, and, when necessary, bailout strategies in difficult gallbladder cases. The strong association between lower CVS scores and higher rates of both intraoperative and postoperative complications reinforces the role of CVS as a critical safety checkpoint.

In conclusion, the study provides robust evidence that CVS is a reliable, reproducible, and essential safety measure in laparoscopic cholecystectomy. Ensuring a complete CVS should remain a primary surgical objective to minimize bile duct injuries and operative complications. Routine documentation, surgeon training, and adherence to standardized criteria are key to enhancing patient outcomes and maintaining high safety standards in gallbladder surgery.

References

1. Mühe E (1986) The first laparoscopic cholecystectomy. Langenbecks Arch Chir Suppl Kongressbd 1986: 267-270.
2. National Institutes of Health (1992) Gallstones and laparoscopic cholecystectomy. NIH Consensus Statement 10: 1-28.
3. Strasberg SM, Hertl M, Soper NJ (1995) An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg 180: 101-125.
4. Way LW, Stewart L, Gantert W (2003) Causes and prevention of laparoscopic bile duct injuries. Ann Surg 237: 460-469.
5. Kambakamba P (2022) Incidence and outcomes of bile duct injury. Ann Surg 275: e556-e563.
6. Chen TH, Shyr YM, Wang SE (2006) Anatomical variations of cystic duct: clinical implications. ANZ J Surg 76: 928-932.
7. Hugh TB (2002) New strategies to prevent laparoscopic bile duct injury. Surgery 132: 826-835.
8. Ong T, Stevens S, D'Souza R (2015) Impact of severe inflammation on safety of laparoscopic cholecystectomy. JSLS 19: e2015.00052.
9. Han HS, Kim HJ, Yoo BC (2011) Laparoscopic cholecystectomy in acute cholecystitis. World J Surg 35: 2454-2458.
10. Duran C (2012) Difficult laparoscopic cholecystectomy: predictive factors. Hepatogastroenterology 59: 1165-1168.
11. Misawa T (2006) Anatomical variations of the biliary tree. World J Gastroenterol 12: 439-442.
12. Flum DR (2003) Bile duct injury during cholecystectomy and survival. JAMA 290: 2168-2173.
13. Bingham J, Rosen M (2010) Complications of laparoscopic cholecystectomy. Surg Clin North Am 90: 1047-1066.
14. van Dijk AH (2017) Outcomes after subtotal cholecystectomy. Ann Surg 266: 755-762.
15. SAGES Safe Cholecystectomy Task Force (2015) Preventing bile duct injury during laparoscopic cholecystectomy. Surg Endosc 29: 331-340.
16. Yokoe M (2018) Tokyo Guidelines 2018: management of acute cholecystitis. J Hepatobiliary Pancreat Sci 25: 89-96.
17. Pahwa HS, Kumar A, Srivastava R (2012) Laparoscopic cholecystectomy in situs inversus: points of technique. BMJ Case Rep 2012: bcr2012006170.
18. Ali AMA (2018) Timing and outcome of bile duct injury repair. Ann R Coll Surg Engl 100: 371-379.
19. Strasberg SM, Brunt LM (2010) Bailout procedures in difficult laparoscopic cholecystectomy. J Am Coll Surg 210: 132-138.
20. Elshaer M (2015) Subtotal cholecystectomy for difficult gallbladders. Ann Surg 262: 1-10.
21. Schols RM (2013) Fluorescence cholangiography with indocyanine green. Surg Endosc 27: 151-157.
22. Mushtaque M , Kema AR , Khanday SA , Bacha UQ (2019) Difficult laparoscopic cholecystectomy and postoperative requirement of analgesics: an observational study. Saudi Journal of Laparoscopy 4.
23. Kwon AH, Inui H (2001) Postoperative complications and hospital stay after laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech 11: 373-378.
24. Nijssen MA (2019) What is the critical view of safety? Surg Endosc 33: 73-80.
25. Lam CM (2015) Evaluation of photo documentation of CVS. Surg Endosc 29: 469-475.