RESEARCH PAPER

Evaluation of importance of Critical View of Safety with respect to Nassar's grading in Laparoscopic Cholecystectomy

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ABSTRACT

Background:

Laparoscopic Cholecystectomy (LC) is considered as a benchmark for the management of symptomatic gallstone disease. However, widespread execution of laparoscopic cholecystectomy was found to be connected with an abrupt surge in the prevalence of vasculobiliary injury (VBI) as compared to its open procedure. Nowadays the correct application of CVS in order to expose mesentery of the gallbladder and to prevent BDI has become a topic of interest. The Nassar grading scale published in 1995 assesses the difficulty of cholecystectomy based on intraoperative findings of gallbladder, its pedicle and the inflammatory adhesions.

Aim and objectives:

This study evaluates the significance of achieving the Critical View of Safety in relation to intraoperative findings, utilizing Nassar's grading scale as the assessment tool.

Material and methods:

This study included 54 adult patients who underwent laparoscopic cholecystectomy. Intraoperative findings and surgical outcomes were documented for each case. Statistical analysis was performed using SPSS software, version 19.

Results:

Our study demonstrates a statistically significant association between the non-feasibility of achieving the Critical View of Safety (CVS) and increasing Nassar's grade. Furthermore, a significant association ($p < 0.05$) was observed in cases where CVS could not be achieved, necessitating the adoption of alternative surgical strategies such as laparoscopic subtotal cholecystectomy or conversion to open surgery.

Conclusion:

Thus, it can be concluded that comparison of Nassar's grading with the achievability of the Critical View of Safety (CVS) demonstrated a significant association between higher Nassar grades and increased difficulty in achieving CVS. The findings indicate that dissection of CVS is particularly challenging in patients categorized as Nassar grade 3 and grade 4.

Keywords: Frozen Calot's triangle, subtotal cholecystectomy, bile duct injury, vasculobiliary injury.

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Introduction: Nowadays approximately > 80% of cholecystectomies are done laparoscopically[1]. It is a minimally invasive gold standard surgery with benefits of small surgical incision, minimal scar, reduced pain postoperatively, early recovery period and quick return to work when competing with open laparotomy procedure[2]. However, a raised complication rate of 0.74 to 2.8% of bile duct injuries was reported in the starting phase of carrier in performing laparoscopic cholecystectomies because of long experience-curve[3]. Despite improvements in equipment and techniques, overall biliary complication rate was reported within a range of 0.1% to 1.5 %[4].

Chances of biliary injury in difficult cholecystectomy is 0.2 to 1.7% whereas chances of biliary injury in routine laparoscopic cholecystectomy is 0.2 to 0.3%[5]. Major cause of post-surgery biliovascular injury comprises incorrect identification of anatomical biliary structures. Multiple factors like misperception,

different anatomy, confined pathological alterations etc. can result in dissection or cutting of mistaken structures such as common bile duct or common hepatic duct, anomalous right sectoral bile duct, and vascular hepatic arteries more commonly right side other then the accurate targets which are cystic duct & artery, leading to complications. The extent of biliovascular structure injury ranges from simple blocking of structures to cutting a large portion of extrahepatic bile ducts for which management requires aggressive biliary reconstruction.[2] Difficult laparoscopic cholecystectomies are linked with a conversion rate of up to 4.35% to open surgery. The main cause for conversion in most of the surgeries are ill defined anatomy, challenging dissection and may be associated with other issues like hemorrhage.

Viewing all these problems, a standard cholecystectomy procedure includes use of Critical View of Safety (CVS), cholangiography if required intraoperatively & the ideal bail-out techniques which were proposed by the Society of American Gastrointestinal and Endoscopic Surgeons(SAGES) consensus and 2018 and 2013 Tokyo Guidelines with a hope to lessen the occurrences of biliary duct injury. A safe cholecystectomy is define as the one which is safe for the patient in a way that there will be no injury to nearby structures such as bile duct, hollow viscera or important vessels and should also be safe for the operating surgeon (no or negligible chances of legal disputes) as well as it must be in effect, easily learned and reproducible, quick and cost-effective.

In order to prevent bile duct injuries CVS is considered as a crucial landmark, but it is often miscalculated or not implemented properly.The concept of the CVS depends on a 2- step approach and has three requisites.Following dissection of fibroareolar tissue in the Calot's triangle, the 2 tubiform structures going to the gallbladder are presumed as the cystic duct & the cystic artery. The next step is dissection of the inferior third portion of the posterior surface of gallbladder from the cystic plate and verifying that only two tube-like structures are connected to the gallbladder and hence unquestionably are the gallbladder structures[6].

Laparoscopic cholecystectomy is currently recommended for surgical management of cases of calculus cholecystitis, acalculous cholecystitis, symptomatic gallstone disease, functional dysmotility gallbladder disorder, gallstone induced pancreatitis & polyps of size > 1 cm or masses of gallbladder [7]. From the time of early 1990s, for routine cases laparoscopic cholecystectomy has mostly superseded the open surgery.[8]

In recent years, laparoscopic surgeons have developed a safer alternative to open subtotal cholecystectomy. The modified version of Laparoscopic Cholecystectomy (LC)surgery is now known as Laparoscopic Sub-total Cholecystectomy or Partial cholecystectomy. It has effectually reduced the rate of conversion to an extremely lowest level in problematic cases where the only alternative choice was to convert the surgery to open. However, this variation of laparoscopic cholecystectomy (LC) requires more competence.[9]

Intraoperative iatrogenically injury to common hepatic duct or common bile duct is the most dreaded complications seen in this surgery and the management of this damage is redirection of flow of bile to small intestine by another surgery.[10] Patients with complications typically experienced symptoms in the first week postoperatively. Diagnostic ultrasonography and/or an abdominal CT scan should be used to commence treatment. Biliary sphincterotomy is required for choledocholithiasis that has not been resolved. Sphincterotomy with ERCP stenting can be done in patients with high grade biliary leaks. In cases of ambiguous CT or ultrasonography results, a HIDA scan to evaluate bile leakage is indicated.[11]

Nassar scale, Cuschieri scale, Parkland Scale, and Sugrue scale - are the different intraoperative scales available to anticipate the difficultness of the surgery. But the drawback is none of them are reliable enough to predict the difficulty.

The Nassar's grade is categorized into four grades and is mainly based on the intraoperative appearance of gallbladder, cystic pedicle and the presence of inflammatory adhesions [5].

The Nassar grading scale was first published in the year 1995. The scale assessed the intraoperative findings of gallbladder, its pedicle and the inflammatory adhesions.The overall Nassar's grade is decided by the worst factor found amongst the three.[12]

Our aim in this study is to assess the importance of Critical View of Safety according to the intraoperative findings with respect to the grade of Nassar's. And to predict the outcome of the surgery.

Materials and methods:

This study was conducted in the Department of General Surgery at a tertiary care hospital in Sangli. All patients undergoing laparoscopic cholecystectomy were included after obtaining informed consent. To evaluate the potential intraoperative difficulties, Nassar's grading system was employed. Nassar's grade is based on the intraoperative appearance of the gallbladder, the

cystic pedicle, and the extent of adhesions, with cases classified into four grades accordingly.

All procedures were performed using the standard four-port laparoscopic cholecystectomy technique. Particular intraoperative parameters recorded included the condition of the gallbladder, the morphology of the cystic pedicle, and the presence of inflammatory adhesions, which determined the Nassar grade. The achievability of the Critical View of Safety (CVS) was documented in each case, along with surgical outcomes across the grades.

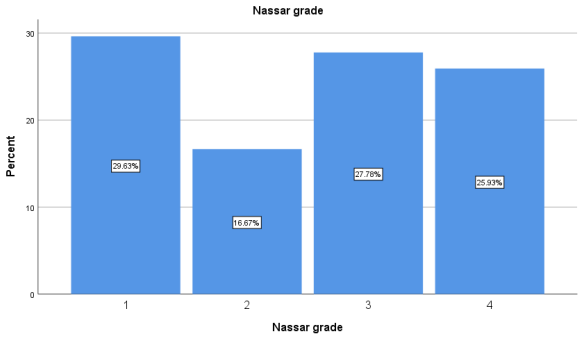
In cases where dissection of the Calot's triangle was rendered difficult due to frozen anatomy, distorted structures, or associated cirrhosis, the decision was made to proceed with a fundus-first approach, laparoscopic subtotal cholecystectomy, or conversion to open subtotal cholecystectomy, as appropriate.

Statistical analysis: After data collection, statistical analysis was performed with the assistance of a statistician using SPSS software, version 26. Descriptive statistics, including mean and standard deviation, were applied to summarize baseline data. Inferential statistics were employed to assess associations and differences between groups. The Chi-square test was used to evaluate the statistical significance of associations between Nassar's grade and surgical outcomes. Independent t-tests were applied to compare differences between groups with or without achievement of the critical view of safety within each Nassar grade. A p-value of <0.05 was considered statistically significant.

Results: The present study was conducted over a period of 18 months in the Department of General Surgery at a tertiary care hospital. A total of 54 cases were included after applying the predefined inclusion and exclusion criteria. Each case was categorized according to Nassar's intraoperative grading system, and the feasibility of achieving the critical view of safety (CVS) was documented. The surgical outcome for each patient was subsequently recorded.

Table 1: Nassar's grade and Number of cases

Nassar's grade	Number of cases	Percentage
1	16	29.6
2	9	16.7
3	15	27.8
4	14	25.9
Total	54	100

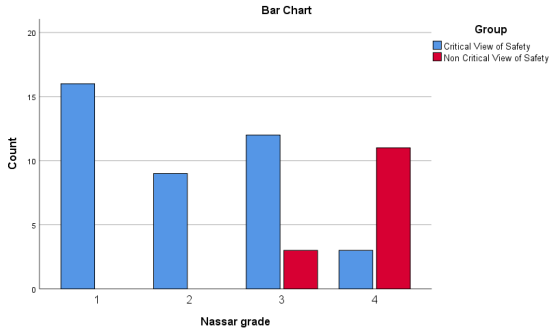


According to the data presented in the table, cases were categorized into Nassar's grades and further divided into two groups based on whether the critical view of safety (CVS) was achieved or not, with the surgical outcome recorded for each group. Of the 54 cases included in this study, 16 (29.6%) were classified as Nassar's grade 1, 9 (16.7%) as grade 2, 15 (27.8%) as grade 3, and 14 (25.9%) as grade 4, based on intraoperative findings.

	Critical view of safety achieved	Critical view of safety Not achieved	Total
Nassar Grade 1	16	0	16
Nassar Grade 2	9	0	9

Nassar Grade 3	12	3	15
Nassar Grade 4	3	11	14
Total	40	14	54

Among the 54 cases analyzed, the critical view of safety (CVS) could not be achieved in 14 patients. Of these, 3 cases were categorized as Nassar's grade 3, while the remaining 11 cases belonged to Nassar's grade 4.



OUTCOME OF THE SURGERY	Frequency	Percentage
LAPAROSCOPIC CHOLECYSTECTOMY	49	90.7
LAPAROSCOPIC SUBTOTAL CHOLECYSTECTOMY	4	7.4
OPEN SUBTOTAL CHOLECYSTECTOMY	1	1.9
Total	54	100

In the present study, various bailout techniques were employed, including the fundus-first approach, laparoscopic subtotal cholecystectomy, and conversion to open surgery. Analysis of the data demonstrated that achieving the critical view of safety (CVS) was particularly challenging in cases classified as Nassar's grades 3 and 4. These findings suggest that higher

From the data presented, it is observed that among the 54 cases, 49 (90.7%) patients underwent successful laparoscopic cholecystectomy. In 4 cases (7.4%), where the critical view of safety (CVS) could not be achieved, laparoscopic subtotal cholecystectomy was performed. One case (1.9%), classified as difficult, required conversion to open subtotal cholecystectomy due to the inability to complete the procedure laparoscopically. All 54 patients had an uneventful postoperative recovery, and there was no mortality.

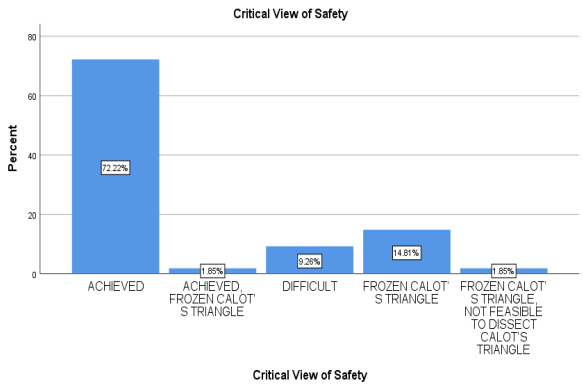
Critical View of Safety	Frequency	Percent
ACHIEVED	39	72.2
ACHIEVED, FROZEN CALOT'S TRIANGLE	1	1.9
DIFFICULT	5	9.3
FROZEN CALOT'S TRIANGLE	8	14.8
FROZEN CALOT'S TRIANGLE, NOT FEASIBLE TO DISSECT CALOT'S TRIANGLE	1	1.9
Total	54	100

From the data presented, it was observed that the critical view of safety (CVS) was achieved in 39 cases (72.2%). In one case (1.9%), where a frozen Calot's triangle was encountered, meticulous dissection allowed attainment of CVS; however, the operative duration was prolonged to two and a half hours. Among the 14 cases in which CVS could not be achieved, a fundus-first approach was employed in 9 cases to complete the procedure laparoscopically, while laparoscopic subtotal cholecystectomy was performed in 4 cases, leaving the posterior gallbladder wall intact. One case was converted to open subtotal cholecystectomy to prevent potential biliary injury.

Nassar grades reliably predict operative difficulty and highlight the importance of employing alternative bailout techniques to ensure safe completion of surgery and to minimize the risk of biliary or vascular injury. Comparison of different Nassar grades with perioperative outcomes revealed a significant association between increasing Nassar grade and the

need for bailout strategies or adjunctive measures, such as elective decompression of a distended gallbladder by puncture or extraction of impacted stones from the gallbladder neck to facilitate dissection. The bar chart further illustrates that Nassar grades 3 and 4 were strongly associated with non-feasibility of CVS, whereas CVS was readily achievable in grades 1 and 2, allowing safe laparoscopic completion of surgery without complications.

Among the 29 cases grouped into Nassar grades 3 and 4, CVS could not be achieved in 14 patients, underscoring the role of Nassar's grading system in predicting the feasibility of achieving CVS. These findings support the utility of Nassar's intraoperative grading as a reliable tool for guiding surgical decision-making and anticipating the need for bailout techniques.



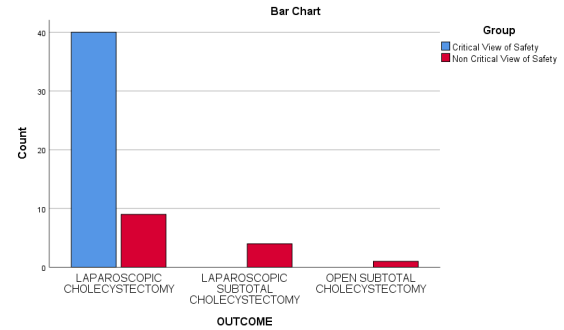
NASSAR'S GRADE	GROUP		Total	Chi-square value	p-value
	Critical View of Safety achieved	Critical View of Safety Not achieved			
1	16	0	16	29.229	0.00
	40.0%	0.0%	29.6%		
2	9	0	9		
	22.5%	0.0%	16.7%		
3	12	3	15		
	30.0%	21.4%	27.8%		
4	3	11	14		
	7.5%	78.6%	25.9%		
Total	40	14	54		
	100.0%	100.0%	100.0 %		

A statistically significant association was found between Nassar's grade and the groups categorized as "Critical View of Safety (CVS) achieved" and "CVS not achieved" ($p < 0.05$; $p = 0.00$ in this study). In Nassar's grade 1, CVS was achieved in 16 cases (40%), while in grade 2 it was achieved in 9 cases (22.5%). Among patients in grade 3, CVS was feasible in 12 cases (30%), whereas in grade 4 it was achieved in only 3 cases (7.5%). Of the 14 cases in which CVS could not be achieved due to a frozen Calot's triangle, 3 (21.4%) belonged to grade 3 and 11 (78.6%) to grade 4.

These findings indicate a significant correlation between higher Nassar's grades and difficulty in achieving CVS. Specifically, CVS dissection was found to be particularly challenging in grades 3 and 4, thereby supporting the predictive utility of Nassar's grading system in anticipating operative difficulty during laparoscopic cholecystectomy.

OUTCOME OF THE SURGERY	Group		Total	Chi-square value	p-value
	Critical Vie	Critical Vie			
	w of Safety achieved	w of Safety not achieved			

	LAPAROSCOPIC CHOLECYSTECTOMY	Count	40	9	49	15.743	0.000
		%	100.0%	64.3%	90.7%		
	LAPAROSCOPIC SUBTOTAL CHOLECYSTECTOMY	Count	0	4	4		
		%	0.0%	28.6%	7.4%		
	OPEN SUBTOTAL CHOLECYSTECTOMY	Count	0	1	1		
		%	0.0%	7.1%	1.9%		
Total		Count	40	14	54		
		%	100.0%	100.0%	100.0%		



A statistically significant association was observed between the surgical outcome and the groups categorized as "Critical View of Safety (CVS) achieved" and "CVS not achieved" ($p < 0.05$). This finding suggests that when CVS is not feasible to achieve, surgeons are more likely to employ established bailout techniques—such as the fundus-first approach, laparoscopic subtotal cholecystectomy, or conversion to open surgery—to ensure safe completion of the procedure while minimizing the risk of complications.

	Groups	N	Mean	SD	SE	Mann-Whitney U test value	p-value
Nassar's Grade	Critical View of Safety achieved	40	2.05	1.011	0.16	43.5	<.001
	Critical View of Safety not achieved	14	3.786	0.426	0.114		

Bar Plots - Nassar's grade and Groups(Critical view of safety achieved and critical view of safety not achieved)

A statistically significant difference was observed between Nassar's grade and the groups categorized as "Critical View of Safety (CVS) achieved" and "CVS not achieved," with a p-value of <0.001 as demonstrated in the table and bar plot. The mean Nassar's grade of 2.05 (corresponding to Grades 1 and 2) predicts a high probability of successful CVS dissection, whereas a mean grade of 3.78 (corresponding to Grades 3 and 4) indicates that achieving CVS is unlikely.

Discussion:

The purpose of this study was to evaluate the importance of the critical view of safety (CVS) in all patients undergoing laparoscopic cholecystectomy under the Department of General Surgery at a tertiary care hospital and medical college, using Nassar's intraoperative grading system. A total of 54 cases were included, with Nassar's grade assessed in each case to determine the feasibility of achieving the CVS and its role in ensuring a successful surgical outcome.

In the present study comprising 54 cases, the critical view of safety (CVS) could not be achieved in 14 patients, whereas in the remaining 40 cases laparoscopic dissection was successfully completed. A fundus-first approach was required in 9 cases, while 4 patients underwent laparoscopic subtotal cholecystectomy. One patient, classified as Nassar's grade 4, required conversion to open subtotal cholecystectomy. None of the patients required reoperation. The principal intraoperative factors contributing to difficulty in laparoscopic cholecystectomy were a distended gallbladder, mucocele with impacted stones, dense inflammatory adhesions, and altered anatomy of the hepatocystic triangle. Nassar's intraoperative grading scale, which incorporates gallbladder condition, cystic pedicle anatomy, and pericholecystic adhesions, demonstrated a statistically significant association with the feasibility of achieving CVS ($p < 0.001$; Mann–Whitney $U = 43.5$). Furthermore, a significant correlation was noted between surgical outcomes and the groups in which CVS was achieved versus not achieved ($p < 0.05$). These findings highlight the value of Nassar's grading system as a reliable predictor of operative difficulty and outcomes in laparoscopic cholecystectomy.

This study demonstrates that the intraoperative application of Nassar's grading system assists surgeons in assessing the achievability of the critical view of safety (CVS) at an early stage of laparoscopic cholecystectomy. The principal intraoperative challenges encountered were a frozen Calot's triangle, which rendered dissection of the cystic artery and duct particularly difficult and, in some cases, led to cystic artery injury, bleeding, or inadvertent gallbladder perforation during separation from the liver bed. Additional factors contributing to operative difficulty included an impacted large stone at the gallbladder neck causing distension, a thickened gallbladder wall, and contracted gallbladder in chronic cases. The main limitations of this study are its relatively small sample size, single-center design, and reliance solely on intraoperative findings for predicting difficult laparoscopic cholecystectomy. Nevertheless, its strength lies in being a prospective study. The findings may serve as a useful guide for junior surgeons by enabling early identification of difficult laparoscopic cholecystectomy using Nassar's grade, thereby allowing them to plan the procedure appropriately or seek timely assistance from senior colleagues.

Our findings indicate a statistically significant association between lower Nassar grades (1 and 2) and the successful achievement of the CVS, whereas higher Nassar grades (3 and 4) were associated with difficulty in CVS dissection. In such cases, the study highlights the importance of adopting appropriate bailout procedures to safely complete the surgery while minimizing vascular and biliary complications.

Conclusion:

The findings of our study demonstrate that Nassar's operating scale is a simple yet highly effective tool for predicting the difficulty of laparoscopic cholecystectomy. Higher Nassar grades were significantly associated with the need for laparoscopic subtotal cholecystectomy, conversion to open surgery, and prolonged operative duration.

Early classification of cases using Nassar's grade at the outset of surgery provides surgeons with valuable insight into the anticipated difficulty of achieving the critical view of safety (CVS). Our observations indicate that in higher Nassar grades, dissection of the CVS is often challenging and, in some cases, may not be feasible.

Based on these findings, we conclude that surgeons should adopt appropriate alternative standard techniques in such situations to minimize the risk of biliary tract injury. Attempting to achieve the CVS or to complete the procedure laparoscopically at all costs may place the patient at unnecessary risk, increase operative time without added benefit, and potentially result in iatrogenic injury.

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