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Role of Rouviere's Sulcus and Critical View of Safety in Preventing Bile Duct Injury During Laparoscopic Cholecystectomy: A Prospective Study.

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Abstract

Background: Laparoscopic cholecystectomy (LC) is considered the gold standard treatment for symptomatic cholelithiasis. Despite advances in laparoscopic techniques, bile duct injury (BDI) remains one of the most serious complications associated with LC. Identification of anatomical landmarks such as Rouviere's sulcus (RS) and attainment of the Critical View of Safety (CVS) have been advocated to minimize biliary injuries. ***Aim:*** To evaluate the usefulness of Rouviere's sulcus and Critical View of Safety in preventing bile duct injuries during laparoscopic cholecystectomy. ***Materials and Methods:*** A prospective observational study was conducted on 50 patients with symptomatic cholelithiasis who underwent laparoscopic cholecystectomy at sir gangaram hospital new delhi from 2023 to 2025. Patients with choledocholithiasis, Mirizzi syndrome, malignancy, previous upper abdominal surgery, and major comorbid conditions were excluded. Intraoperative identification of Rouviere's sulcus and achievement of CVS were documented. Operative difficulty, complications, operative time, and postoperative outcomes were assessed. ***Results:*** Out of 50 patients, 44 (88%) were females and 6 (12%) were males. The mean age was 38.72 years. Rouviere's sulcus was identified in the majority of patients, either as a well-defined cleft or faint line. Critical View of Safety was successfully achieved in almost all cases. No major bile duct injury occurred. Minor complications included bile spillage, gallbladder perforation, and minor bleeding, all managed laparoscopically. Difficult laparoscopic cholecystectomy was associated with thickened gallbladder wall, adhesions, and prolonged operative duration. ***Conclusion:*** Routine identification of Rouviere's sulcus along with strict adherence to the Critical View of Safety technique significantly enhances operative safety and helps prevent bile duct injury during laparoscopic cholecystectomy.

Keywords: Laparoscopic cholecystectomy, Rouviere's sulcus, Critical View of Safety, bile duct injury, cholelithiasis, laparoscopic surgery.

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INTRODUCTION

Gallstone disease is one of the most common gastrointestinal disorders requiring surgical intervention worldwide. Laparoscopic cholecystectomy (LC) has become the gold standard procedure for symptomatic cholelithiasis because of reduced postoperative pain, shorter hospital stay, better cosmetic outcomes, and early return to routine activities compared with open cholecystectomy.[1,2]

The first laparoscopic cholecystectomy was performed by Philippe Mouret in 1987, after which the procedure rapidly gained worldwide acceptance.[3] In India, the first laparoscopic cholecystectomy was performed by Tehempton Udwadia in 1990.[4] Despite major advancements in laparoscopic techniques and instrumentation, bile duct injury (BDI) remains one of the most feared complications of laparoscopic cholecystectomy.[5]

The incidence of bile duct injury during laparoscopic cholecystectomy has been reported to range from 0.3% to 0.8%, which is significantly higher than that seen with open cholecystectomy.[6,7] Bile duct injury can result in severe morbidity, repeated interventions, prolonged hospitalization, biliary cirrhosis, impaired quality of life, and medicolegal consequences.[8]

Misidentification of anatomy is considered the most important cause of bile duct injury during laparoscopic cholecystectomy.[9] Acute inflammation, fibrosis, obesity, adhesions, anatomical variations, and difficult exposure of Calot's triangle further increase operative difficulty and predispose to injury.[10]

To minimize these complications, several strategies have been proposed for safer laparoscopic cholecystectomy. Among these, identification of Rouviere's sulcus and achievement of the Critical View of Safety (CVS) are considered highly effective methods for preventing biliary injuries.[11]

Rouviere's sulcus is a cleft on the liver surface running to the right of the hepatic hilum and usually containing the right portal pedicle.[12] Since the common bile duct lies below the level of the sulcus, dissection performed above this landmark provides a safer operative plane.[13]

The Critical View of Safety technique was introduced by Steven Strasberg in 1995.[14] The CVS technique requires complete clearance of the hepatocystic triangle, separation of the lower gallbladder from the liver bed, and visualization of only two structures entering the gallbladder before clipping and division.[15]

Several studies have demonstrated that routine use of Rouviere's sulcus and CVS significantly reduces the risk of bile duct injury during laparoscopic cholecystectomy.[16,17] The present study was conducted to evaluate the role of these safety principles in preventing bile duct injury and improving operative outcomes during laparoscopic cholecystectomy.

Aim and Objectives

1. To study the usefulness of navigation principles during laparoscopic cholecystectomy.
2. To evaluate the role of Rouviere's sulcus in preventing bile duct injury.
3. To assess the importance of Critical View of Safety during laparoscopic cholecystectomy.
4. To determine intraoperative and postoperative complications associated with laparoscopic cholecystectomy.
5. To assess factors associated with difficult laparoscopic cholecystectomy.

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted in the Department of General Surgery at sir gangaram hospital new delhi from 2023 to 2025.

Study Population

A total of 50 patients diagnosed with symptomatic cholelithiasis and planned for laparoscopic cholecystectomy were included in the study.

Inclusion Criteria

- Symptomatic cholelithiasis
- Patients willing to participate in the study
- Patients fit for laparoscopic surgery

Exclusion Criteria

- Choledocholithiasis
- Mirizzi syndrome
- Cholangitis
- Previous upper abdominal surgery
- Gallbladder malignancy
- Cirrhosis liver
- Coagulation disorders
- Severe systemic illness
- Patients requiring conversion to open surgery

Preoperative Evaluation

All patients underwent detailed history taking, clinical examination, hematological investigations, liver function tests, renal function tests, ultrasonography of the abdomen, and anesthetic assessment.
Difficulty scoring was assessed using the Randhawa scoring system, which included age, sex, body mass index, gallbladder wall thickness, impacted stone, history of hospitalization, palpable gallbladder, and pericholecystic collection.

Operative Technique

All surgeries were performed under general anesthesia using a standard four-port laparoscopic technique. Pneumoperitoneum was created using a Veress needle through the infraumbilical port.

The patient was positioned in reverse Trendelenburg position with left tilt. The gallbladder fundus was retracted cephalad and laterally. Rouviere's sulcus was identified before commencement of dissection.
Dissection was carried out above the level of Rouviere's sulcus. The hepatocystic triangle was cleared, and the Critical View of Safety was achieved before clipping and dividing the cystic duct and cystic artery.

The gallbladder was dissected from the liver bed and extracted through the epigastric port. Hemostasis was secured, and a drain was placed when required.

Parameters Evaluated

Intraoperative Parameters

- Identification of Rouviere's sulcus
- Achievement of CVS
- Operative time
- Intraoperative complications
- Gallbladder perforation
- Bleeding
- Bile spillage

Postoperative Parameters

- Pain
- Fever
- Bile leak
- Wound infection
- Hospital stay

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using descriptive statistical methods. Results were expressed in percentages, means, and tables.

RESULTS

Demographic Profile

Out of 50 patients included in the study, 44 (88%) were females and 6 (12%) were males, demonstrating a marked female predominance in gallstone disease. The female-to-male ratio was approximately 7:1.

Most patients belonged to the third and fourth decades of life. The mean age of the study population was 38.72 years, with an age range of 10 to 70 years. The highest incidence was observed in the 31–40 years age group (36%), followed by the 20–30 years age group (28%).

Clinical Presentation

Pain in the right hypochondrium was the most common presenting symptom and was observed in almost all patients. Associated symptoms included dyspepsia, nausea, vomiting, flatulence, and occasional fever. None of the patients had jaundice because cases with choledocholithiasis and biliary obstruction were excluded from the study.

Ultrasonographic Findings

Ultrasonography confirmed cholelithiasis in all patients. Multiple gallstones were more common than solitary stones. Thickened gallbladder wall and pericholecystic collection were observed in patients with recurrent attacks of cholecystitis and were associated with difficult dissection.

Intraoperative Findings

Rouviere's sulcus was identified in the majority of patients either as:

- Well-defined sulcus
- Faint line
- Fused sulcus

Only a small proportion of patients had a non-identifiable sulcus.

The use of Rouviere's sulcus as an anatomical landmark provided orientation during dissection and ensured that the plane of dissection remained safely above the common bile duct.
Critical View of Safety was achieved successfully in almost all patients before clipping and division of cystic structures.

Operative Difficulty

Difficult laparoscopic cholecystectomy was associated with:

- Dense adhesions
- Thickened gallbladder wall
- Impacted stone at Hartmann's pouch
- Distorted Calot's triangle
- Acute inflammatory changes

Patients with difficult cholecystectomy had longer operative times compared to routine cases.

Operative Time

Most surgeries were completed within 60–90 minutes. Prolonged operative duration was noted in patients with adhesions, empyema, or contracted gallbladder.

Intraoperative Complications

Minor complications encountered during surgery included:

- Gallbladder perforation
- Bile spillage
- Minor bleeding from the gallbladder bed

These complications were managed laparoscopically without conversion to open surgery.
Importantly, no major bile duct injury occurred in this study.

Postoperative Complications

Postoperative complications were minimal. A few patients experienced mild postoperative pain and transient nausea. No patient developed biliary peritonitis, major bile leak, or mortality.
Most patients were discharged within 2–3 postoperative days.

DISCUSSION

Laparoscopic cholecystectomy has become the preferred surgical treatment for symptomatic gallstone disease because of its minimally invasive nature and favorable postoperative outcomes.[1,2] However, bile duct injury continues to remain a major concern despite increasing surgical expertise and technological advancements.[5]

In the present study, females constituted 88% of patients, showing a clear female predominance. Similar findings have been reported in previous studies, where gallstone disease was found to be more common among females due to hormonal and metabolic factors.[18]

The mean age in our study was 38.72 years, which correlates well with previous studies reporting a higher prevalence of symptomatic cholelithiasis in the third and fourth decades of life.[19]

Rouviere's sulcus was identified in the majority of patients in our study. Hugh et al. reported that Rouviere's sulcus is identifiable in approximately 78–90% of patients and serves as an important extrabiliary anatomical landmark during laparoscopic cholecystectomy.[11] Zubair et al. similarly demonstrated that the use of Rouviere's sulcus significantly improves orientation during dissection and helps avoid injury to the common bile duct.[20]

The importance of Rouviere's sulcus lies in the fact that the cystic duct and cystic artery are located superior to the sulcus, whereas the common bile duct lies inferior to it.[12] Therefore, keeping dissection above the level of the sulcus ensures a safer operative plane even in cases with distorted anatomy due to inflammation or fibrosis.[13]

The Critical View of Safety was achieved in almost all patients in the present study. Strasberg first described the CVS technique as a method to prevent misidentification injuries during laparoscopic cholecystectomy.[14] Multiple studies have since validated this technique as one of the safest approaches for preventing bile duct injury.[15,21]

No major bile duct injury occurred in our study. Similar findings were reported by Sanjay et al., who demonstrated that strict adherence to the Critical View of Safety significantly reduces biliary complications during laparoscopic cholecystectomy.[22]

Difficult laparoscopic cholecystectomy in our study was associated with thickened gallbladder wall, dense adhesions, impacted stones, and distorted anatomy. Previous studies have similarly identified recurrent inflammation, fibrosis, and acute cholecystitis as important predictors of difficult surgery.[23]

Minor complications such as gallbladder perforation and bile spillage were encountered in a few patients but were managed successfully laparoscopically. No mortality or major postoperative morbidity was observed.
The findings of the present study support the growing evidence that routine identification of Rouviere's sulcus combined with achievement of the Critical View of Safety can significantly improve operative safety and reduce the incidence of bile duct injury during laparoscopic cholecystectomy.

CONCLUSION

Laparoscopic cholecystectomy is a safe and effective procedure for symptomatic gallstone disease when performed with meticulous surgical technique and proper anatomical orientation. The identification of Rouviere's sulcus provides a reliable extrabiliary landmark that helps surgeons maintain safe dissection planes during laparoscopic cholecystectomy. Achievement of the Critical View of Safety before clipping or division of cystic structures is equally essential for preventing misidentification injuries.

The combined use of Rouviere's sulcus and Critical View of Safety significantly reduces the risk of bile duct injury and improves overall surgical safety. These principles should be routinely practiced and incorporated into surgical training programs for safe laparoscopic cholecystectomy.

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