Section: Surgery

Original Research Article

CRITICAL VIEW OF SAFETY AND ROUVIERE'S SULCUS AS A GUIDE FOR SAFE LAPAROSCOPIC CHOLECYSTECTOMY- A CROSS-SECTIONAL STUDY

Amritanjay Srivastava[1], Manjul Mohan[2], Sharad Seth[3]

[1]*Junior Resident, Postgraduate Department of Surgery, Rohilkhand Medical College, Hospital and Research Centre, Bareilly, Uttar Pradesh, India*
[2]*Professor and Unit Head, Postgraduate Department of Surgery, Rohilkhand Medical College, Hospital and Research Centre, Bareilly, Uttar Pradesh, India*
[3]*Professor and HOD, Postgraduate Department of Surgery, Rohilkhand Medical College, Hospital and Research Centre, Bareilly, Uttar Pradesh, India*

Received *: 25/04/2026*
Received in revised form *: 19/05/2026*
Accepted *: 22/05/2026*

Corresponding Author:
Dr. Amritanjay Srivastava,
Junior Resident, Postgraduate Department of Surgery, Rohilkhand Medical College, Hospital and Research Centre, Bareilly, Uttar Pradesh, India.
Email: amritanjaysrivastava@gmi.com

DOI: 10.70034/ijmedph.2026.2.388

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 2322-2326

ABSTRACT

Background: Bile duct injury remains one of the most serious complications of laparoscopic cholecystectomy. Rouviere's Sulcus (RS) is an important extra-biliary anatomical landmark that may facilitate safe dissection and achievement of the Critical View of Safety (CVS). The present study evaluated the incidence, morphology, and clinical significance of RS in safe laparoscopic cholecystectomy.

Materials and Methods: This cross-sectional study was conducted in the Department of Surgery, Rohilkhand Medical College and Hospital, Bareilly, from 1st November 2024 to 31st October 2025. A total of 265 patients undergoing laparoscopic cholecystectomy were included. Intraoperative assessment included identification of RS, its morphological type, Calot's triangle anatomy, achievement of CVS, operative duration, complications, and postoperative hospital stay. Statistical analysis was performed using SPSS version 23.0, with $p < 0.05$ considered statistically significant.

Results: All biliary and vascular injuries occurred exclusively in RS-absent cases. RS absence was associated with frozen Calot's triangle, dense adhesions, difficult dissection, and increased operative complexity. Mean operative duration was shorter in RS-present cases (51.55 ± 23.78 min) compared to RS-absent cases (54.74 ± 27.47 min).

Conclusion: Rouviere's Sulcus is a consistent and valuable anatomical landmark that improves orientation during laparoscopic cholecystectomy and facilitates safe achievement of CVS. Routine identification of RS may reduce biliary and vascular injuries and should be incorporated into standard safe cholecystectomy protocols.

Keywords: Rouviere's Sulcus, Critical View of Safety, Laparoscopic Cholecystectomy, Calot's Triangle, Bile Duct Injury.

INTRODUCTION

Gallstone disease is one of the most common disorders of the biliary system and a major cause of morbidity worldwide.[1] Cholelithiasis affects approximately 10–20% of the adult population, with variations across regions due to differences in diet, genetics, and lifestyle.[2] Symptomatic gallstone disease remains one of the most frequent indications for abdominal surgery globally.[3]

The advent of laparoscopic cholecystectomy (LC) in 1987 by Philippe Mouret revolutionised the field of general surgery.[4] It soon became the gold standard for symptomatic gallstone disease due to its smaller incision, faster recovery, reduced postoperative pain, and shorter hospital stay compared to open surgery.[5,6] Within a few years, Laparoscopic Cholecystectomy (LC) was universally adopted as the procedure of choice for Cholelithiasis.

Despite its overwhelming advantages, the early period following the introduction of LC witnessed a

marked increase in the incidence of bile-duct injuries (BDIs) — nearly three times higher than in the open era.[7,8] The principal reason identified was misidentification of biliary anatomy, often due to inexperience or difficult anatomy, or misinterpretation visual cues in Calot's triangle.

In 1995, Steven Strasberg introduced the concept of the Critical View of Safety (CVS),[9] which remains the cornerstone of safe laparoscopic cholecystectomy. The CVS requires fulfillment of three essential criteria before division of any ductal or arterial structure: (1) complete clearance of fibrofatty tissue within Calot's triangle, (2) dissection of the lower third of the gallbladder from the cystic plate, and (3) identification of only two structures entering the gallbladder—the cystic duct and cystic artery. Only after these steps are confirmed should clipping and division be performed, thereby significantly reducing biliary and vascular injuries.[10] Current recommendations from Society of American Gastrointestinal and Endoscopic Surgeons (2018),[11] the Tokyo Guidelines,[12] and the World Society of Emergency Surgery (2023),[13] emphasise meticulous achievement and documentation of CVS as the definitive checkpoint of safe laparoscopic dissection.

Parallel to these safety concepts, interest in anatomical landmarks guiding safe dissection has re-emerged. Rouviere's Sulcus (RS), first described by Henri Rouviere in 1924,[14] is a 2–5 cm fissure on the posterior aspect of the right hepatic lobe, situated above the plane of the common bile duct. As the plane of RS lies below the cystic duct and artery but above the common bile duct, maintaining dissection above this sulcus helps prevent major biliary and vascular injuries.[15] Recent studies by Reynaud (2018), Basukala (2022), Sharma (2023), and Grüter (2024) demonstrated RS as a constant and easily identifiable landmark in 70–85% of individuals,[16] particularly useful in difficult cholecystectomies where Calot's triangle is obscured.

RS acts as a fixed extrahepatic landmark demarcating the safe zone of dissection, while dissection below its plane may result in catastrophic bile duct or vascular injury.[15,16] Morphologically, RS may appear as open, closed, slit, or scar type,[17] but regardless of its form, it serves as a "natural compass" during laparoscopic dissection.[18] To further improve orientation, the "R4U line" has been proposed—a conceptual line extending from Rouviere's sulcus to the base of Couinaud's segment IV and the umbilical fissure.[19,20] This line defines the boundary of the safe dissection zone in Calot's triangle; remaining above it confines dissection to the cystic duct and cystic artery, whereas crossing below increases the risk of injury to the common hepatic or common bile duct.[20]

Together, the R4U line as an orienting guide and CVS as a confirmatory endpoint form the dual foundation of safe laparoscopic cholecystectomy20.

While CVS is well established,[11,12] complications still occur in difficult cholecystectomies.[7,8] Incorporating RS identification as an initial safety checkpoint may reduce misidentification errors and facilitate safer achievement of CVS. Despite the documented constancy of RS, its routine utilisation and documentation remain inconsistent,[19] highlighting the need to evaluate its role in the Indian population and its correlation with successful CVS achievement and prevention of bile duct injury.

MATERIALS AND METHODS

The cross-sectional study was conducted in the Department of General Surgery, Rohilkhand Medical College and Hospital, Bareilly, U.P. over a period from 1st November 2024-31st October 2025. Institutional ethics committee approval was taken prior to conducting this study.265 patients were selected for the study fulfilling the inclusion criteria.

Inclusion Criteria

All adult patients above the age of 18 years, who will be undergoing standard Laparoscopic Cholecystectomy procedure.

A detailed preoperative evaluation was carried out in all patients, including complete clinical history, thorough physical examination, routine laboratory investigations, and abdominal ultrasonography. Additional imaging in the form of Contrast Enhanced Computed Tomography (CECT abdomen) and/or Magnetic Resonance Cholangiopancreatography (MRCP) was performed whenever indicated to assess biliary anatomy and associated pathology.

All patients underwent standard laparoscopic cholecystectomy under general anaesthesia. Patients were initially positioned supine and subsequently placed in reverse Trendelenburg position with slight right-side elevation to facilitate exposure of the gallbladder. The operating surgeon stood on the patient's left side. Pneumoperitoneum was created using the Veress needle technique.

A standard four-port technique was used, consisting of a 10-mm sub-umbilical port for insertion of a 30° laparoscope, a 10-mm epigastric working port, a 5-mm right midclavicular port, and a 5-mm right flank port for gallbladder retraction. After placement of trocars and laparoscopic instruments, Calot's triangle and the hepatocystic triangle were carefully dissected and cleared of fat and fibrous tissue. The gallbladder was partially separated from the liver bed to expose the cystic plate, and the Critical View of Safety (CVS) was achieved by identifying only two structures entering the gallbladder—the cystic duct and cystic artery. Clips were applied to both structures, followed by division. The gallbladder was dissected from the liver bed using electrocautery and removed through the epigastric or umbilical port. A 16 F subhepatic drain was placed at the end of the procedure.

During surgery, the anatomy of Calot's triangle, presence and morphological type of Rouviere's Sulcus, variations in extrahepatic biliary and vascular anatomy, achievement of Critical View of Safety, and duration of surgery were documented. All intraoperative, immediate postoperative, and late complications were recorded in a predesigned case record form.

The collected data were entered and analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Qualitative variables were expressed as frequency and percentage, including incidence of Rouviere's Sulcus, Calot's triangle anatomy, achievement of Critical View of Safety, biliary/vascular complications, duration of surgery, and postoperative hospital stay. Association between qualitative variables was analysed using Chi-square test with continuity correction or Fisher's Exact test wherever applicable. Appropriate statistical tests were applied according to the type and distribution of data. A p-value < 0.05 was considered statistically significant.

RESULTS

Out of 265 study participants, Rouviere's Sulcus (RS) was identified in 207 cases, accounting for 78.1% of the total study population, while it was absent in 58 cases (21.9%). This finding indicates that RS is a commonly identifiable anatomical landmark during surgery in the majority of patients. The high prevalence of RS supports its usefulness as an important surgical landmark for safe dissection during laparoscopic cholecystectomy.

Table 1A: Incidence and Morphological Types of Rouviere's Sulcus (n = 265)

Variable	Category	Number (n)	Percentage (%)
Rouviere's Sulcus (RS)	Present	207	78.1
	Absent	58	21.9

Table 1B: Morphological Types of Rouviere's Sulcus Identified (n = 207)

Type of RS	Number (n)	Percentage (%)
Closed type	131	63.3
Open type	35	16.9
Scar type	23	11.1
Slit type	18	8.7

Among the 207 cases in which RS was present, the closed type was the most common morphological variant, observed in 131 patients (63.3%). The open type was identified in 35 cases (16.9%), followed by the scar type in 23 cases (11.1%) and the slit type in 18 cases (8.7%). These findings demonstrate that the closed type of RS is the predominant anatomical pattern encountered during surgery, whereas slit and scar types are relatively less common.

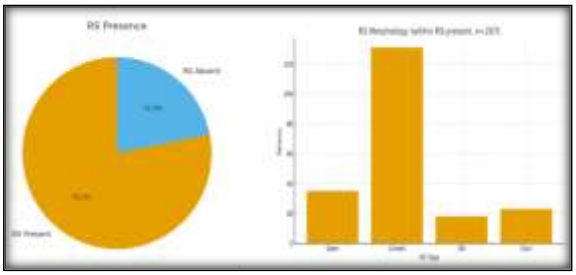


Table 2: Injuries in RS Present versus RS Absent Cases

RS status	Number of injuries
RS present (n=207)	0
RS absent (n=58)	3

No injuries were reported among the 207 cases in which RS was present. In contrast, all 3 recorded injuries occurred in the 58 cases where RS was absent. This observation suggests that the presence of RS may provide a protective role during surgery by serving as a reliable anatomical landmark, thereby reducing the likelihood of operative injury.

Table 3: Comparison of RS according to complications

Complications	RS				Chi Square Test	p value
	Present		Absent			
	N	%	N	%		
Absent	207	79.01	55	20.99	2.06	0.67
Present	0	0	3	100.0		
Total	207	78.1	58	21.9		

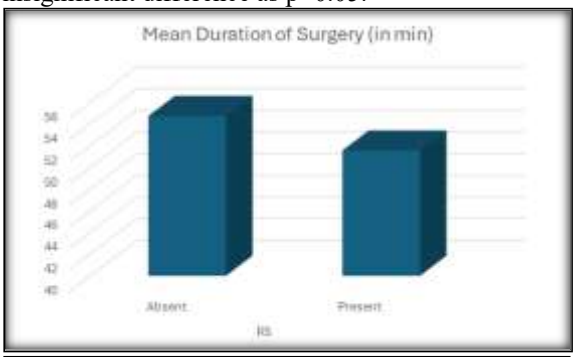
Among patients without complications, RS was present in 207 cases (79.01%) and absent in 55 cases (20.99%). In contrast, among patients who developed complications, RS was absent in all 3 cases (100%), while none of the complication cases had RS present. Statistical analysis using the Chi-square test showed a value of 2.06 with a p-value of 0.67, indicating that the association between RS presence and complications was not statistically significant. Although complications were observed

only in cases where RS was absent, the difference did not reach statistical significance, possibly due to the small number of complications recorded in the study.

Table 4: Mean duration of surgery comparison according to RS

RS	Mean Duration of Surgery (in min)	SD	t test	p value
Absent	54.74	27.47	0.76	0.38
Present	51.55	23.78		

Mean duration of surgery (in min) among subjects with and without RS was 51.55±23.78 and 54.74±27.47 minutes respectively with statistically insignificant difference as p>0.05.



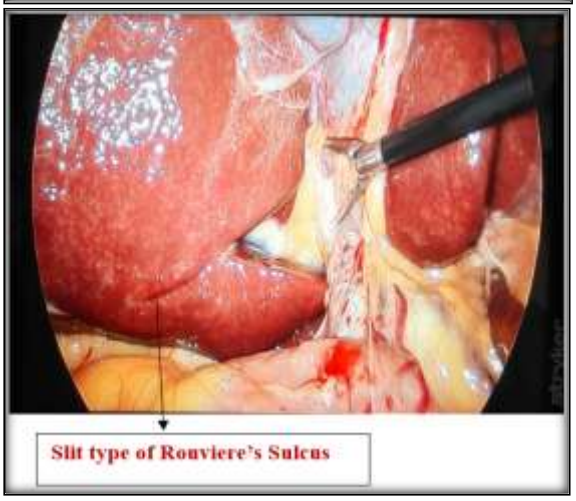


Image 1: Presence of Slit type of Rouviere's Sulcus and dissection being done above the level of R4U line.

Image 2: Critical View of Safety was achieved with help of Rouviere's Sulcus. After dissection in Calot's triangle, only 2 structures were present one is Cystic artery and another in Cystic duct and between them inferior surface of liver is visible.

DISCUSSION

The present prospective observational study evaluating Rouviere's Sulcus (RS) in 265 patients undergoing laparoscopic cholecystectomy in Department of Surgery, Rohilkhand Medical College, Bareilly provides comprehensive insight into the anatomical reliability, operative importance, and clinical implications of this landmark in enhancing the safety of biliary surgery.

The present study demonstrated that Rouviere's Sulcus (RS) was present in 78.1% of cases, while it was absent in 21.9% of patients undergoing laparoscopic cholecystectomy. This incidence is comparable with findings reported in previous studies, where RS has been described as a constant and reliable anatomical landmark in the majority of patients. Sharma S, Singh A, and Bansal N similarly reported high RS visibility rates, supporting its usefulness during safe biliary dissection.[21] The relatively lower visibility in some cases may be attributed to acute inflammation, fibrosis, dense adhesions, and distorted hepatocystic anatomy, as observed by Misawa, Naguib, and Nagata.[22]

Regarding the morphological pattern of RS, the closed type was the most common variant identified in the present study (63.3%), followed by open type (16.9%), scar type (11.1%), and slit type (8.7%). Similar morphological distributions have been documented in earlier anatomical and laparoscopic studies, where the closed type predominated. Despite variations in morphology, all forms of RS provide an important horizontal reference plane for maintaining dissection safely above the biliary hilum and avoiding injury to vital structures.[23]

A major finding of the present study was that all biliary and vascular injuries occurred exclusively in the RS-absent group, whereas no injury was observed when RS was identified. Two cases of common bile duct injury and one case of right hepatic artery injury were recorded in RS-absent patients. This observation strongly supports the safety concept proposed by Hugh et al., who emphasized that dissection above the plane of RS significantly reduces bile duct injury.[23] Similarly, Way demonstrated that most bile duct injuries result from misinterpretation of anatomy rather than technical error alone.[24] RS therefore acts as a fixed extra-biliary landmark that helps surgeons maintain a safe dissection plane during laparoscopic cholecystectomy.

The comparison of RS according to complications further demonstrated that all complications occurred in the RS-absent group, while no complication was recorded in RS-present cases. Although the

association was not statistically significant (p = 0.67), likely due to the small number of complications, the findings remain clinically important. These results support previous observations that inability to identify RS is commonly associated with severe inflammation, frozen Calot's triangle, and distorted anatomy, all of which increase operative difficulty and complication risk.[22,23]

The mean duration of surgery was shorter in RS-present cases (51.55 ± 23.78 minutes) compared to RS-absent cases (54.74 ± 27.47 minutes), although the difference was not statistically significant (p = 0.38). This trend suggests that identification of RS facilitates quicker anatomical orientation and safer dissection during the early stages of surgery. Similar observations have been reported in previous studies, where early identification of reliable anatomical landmarks improved operative efficiency and reduced unnecessary tissue handling.[25]

CONCLUSION

In summary, the present prospective observational study in 265 patients establishes that Rouviere's sulcus is a constant, reliable and surgically invaluable landmark. Its routine identification and use as a reference line for dissection, in conjunction with the Critical View of Safety, substantially enhance the safety profile of laparoscopic cholecystectomy, particularly in the face of difficult or distorted anatomy. The study strongly supports making Rouviere's Sulcus guided dissection an integral component of standard operative practice and surgical education in gallstone disease.

REFERENCES

1. Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis. Best Pract Res Clin Gastroenterol. 2006;20(6):981–96.
2. Stinton LM, Shaffer EA. Epidemiology of gallstones. Gastroenterol Clin North Am. 2010;39(2):157–69.
3. Everhart JE, Ruhl CE. Burden of digestive diseases in the United States. Gastroenterology. 2009;136(2):376–86.
4. Mouret P. From the first laparoscopic cholecystectomy to the frontiers of laparoscopic surgery: the future perspectives. Dig Surg. 1991;8(2):124–5.
5. Shea JA, Healey MJ, Berlin JA, Clarke JR, Malet PF, Staroscik RN, et al. Mortality and complications associated with laparoscopic cholecystectomy: a meta-analysis. Ann Surg. 1996;224(5):609–20.
6. National Institutes of Health. NIH Consensus Conference: gallstones and laparoscopic cholecystectomy. JAMA. 1993;269(8):1018–24.
7. Way LW, Stewart L, Gantert W, Liu K, Lee CM, Whang K, et al. Causes and prevention of laparoscopic bile duct injuries. Ann Surg. 2003;237(4):460–9.
8. Hugh TB. New strategies to prevent laparoscopic bile duct injury—surgeons can learn from pilots. Surgery. 2002;132(5):826–35.
9. Strasberg SM. Avoidance of biliary injury during laparoscopic cholecystectomy. J Hepatobiliary Pancreat Surg. 2002;9(5):543–7.
10. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg. 1995;180(1):101–25.
11. Brunt LM, Deziel DJ, Telem DA, Strasberg SM, Aggarwal R, Asbun HJ, et al. Safe cholecystectomy multi-society practice guideline and consensus on prevention of bile duct injury. Surg Endosc. 2020;34(7):2827–55.
12. Okamoto K, Suzuki K, Takada T, Strasberg SM, Asbun HJ, Endo I, et al. Tokyo Guidelines 2018: flowchart for the management of acute cholecystitis. J Hepatobiliary Pancreat Sci. 2018;25(1):55–72.
13. Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World J Emerg Surg. 2020;15:61.
14. Rouvière H. L'anatomie du foie et des voies biliaires. Paris: Masson; 1924.
15. Hugh TB, Kelly MD. Rouviere's sulcus: a useful landmark in laparoscopic cholecystectomy. Br J Surg. 1997;84(9):1253–4.
16. Reynaud P, Ouaïssi M, Soprani A, Sielezneff I, Pirro N, Beyer L, et al. Rouviere's sulcus: myth or reality in laparoscopic cholecystectomy? Surg Endosc. 2018;32(8):3440–7.
17. Basukala S, Sigdel B, Bhattarai S. Anatomic variations and clinical significance of Rouviere's sulcus. Int J Surg. 2022;99:106–12.
18. Sharma D, Gupta N, Kumar B. Clinical relevance of Rouviere's sulcus in laparoscopic cholecystectomy. J Minim Access Surg. 2023;19(3):221–7.
19. Grüter L, Banz V, Candinas D, Beck-Schimmer B, Beldi G. Anatomical analysis of Rouviere's sulcus: a cadaveric study. Clin Anat. 2024;37(1):123–9.
20. Gupta V, Kumar S. The R4U line: a novel landmark for safe laparoscopic cholecystectomy. Surg Innov. 2020;27(4):411–8.
21. Sharma S, Sood N, Singh A, Dahiya D, Bansal N, Monga A. Rouviere's sulcus analysis: a critical safety analysis and a guide to safe laparoscopic cholecystectomy. Cureus. 2023;15(5):e38325.
22. Cheruiyot I, Ngigi B, Odula P, Mwachaka P. The prevalence of the Rouviere's sulcus: a meta-analysis with implications for laparoscopic cholecystectomy. Clin Anat. 2021;34(4):556–64.
23. van de Graaf FW, Zaïmi I, Stassen LPS, Lange JF. Safe laparoscopic cholecystectomy: a systematic review of bile duct injury prevention. Int J Surg. 2018;60:164–72.
24. Sgaramella LI, Gurrado A, Pasculli A, de Angelis N, Memeo R, Prete FP, et al. The critical view of safety during laparoscopic cholecystectomy: Strasberg yes or no? An Italian multicentre study. Surg Endosc. 2021;35(7):3698–708
25. Péré G, Benvegnu V, Mercé C, Maulat C, Carrère N, Lopez R. The sulcus of the caudate process (Rouviere's sulcus): anatomy and clinical applications—a review of current literature. Surgical and Radiologic Anatomy. 2020 Dec;42(12):1441-6.