



Original Article

Relevance of Rouvieres Sulcus in Laparoscopic Cholecystectomy

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ABSTRACT

Background: Bile duct injury remains one of the most serious complications of laparoscopic cholecystectomy. Rouviere's sulcus (RS) is considered a reliable anatomical landmark that helps surgeons identify the safe plane of dissection and minimize biliary injuries.

Aim: To evaluate the association between Rouviere's sulcus visibility and intraoperative complications, operative time, and postoperative hospital stay in patients undergoing laparoscopic cholecystectomy.

Materials and Methods: A retrospective observational study was conducted at King George Hospital between March and October 2024. A total of 250 patients with uncomplicated gallstone disease who underwent laparoscopic cholecystectomy were included. Patients were categorized into three groups based on the visibility of Rouviere's sulcus: initially visible, visible after adhesiolysis, and absent. Intraoperative and postoperative complications, operative duration, and hospital stay were compared using ANOVA with Bonferroni correction.

Results: Rouviere's sulcus was initially visible in 167 (66.8%) patients, became visible after adhesiolysis in 76 (30.4%), and was absent in 7 (2.8%). The lowest complication rate and shortest operative time (38.86 ± 13.95 minutes) were observed when the sulcus was identified initially. Patients requiring adhesiolysis had significantly longer operative times (84.89 ± 45.30 minutes; $p < 0.001$) and more complications.

Conclusion: Early identification of Rouviere's sulcus significantly improves surgical safety by reducing operative time and perioperative complications. It should be routinely used as an anatomical landmark during laparoscopic cholecystectomy whenever present.

Keywords: Rouvieres Sulcus, Laparoscopic, Cholecystectomy, Rouviere's sulcus (RS).

INTRODUCTION

First laparoscopic cholecystectomy was performed by professor Erich Muhe in 1985. Laparoscopic cholecystectomy is now considered to be the gold standard treatment for gallstone disease [1].

The frequency of complications associated with laparoscopic cholecystectomy varies from 0.5 to 6%. Incidence of common bile duct injury being at 0.1 to 0.6%, and that of large blood vessel injury being at 0.04 to 1.22%, depending on different studies [2].

Bile duct injury is the gravest complication during laparoscopic cholecystectomy, and it is a major unresolved surgical problem. Given the overall morbidity, mortality, and decreased long term survival associated with bile duct injury, the importance of safe operative measures for laparoscopic cholecystectomy cannot be over emphasised. Gallstone disease is one of the commonest gastrointestinal disorders requiring surgical intervention. Laparoscopic cholecystectomy has become the gold standard treatment because of reduced postoperative pain, shorter hospital stay, rapid recovery, and improved cosmetic outcomes. Despite these advantages, bile duct injury continues to be a devastating complication associated with

considerable morbidity, mortality, repeated surgical procedures, and medicolegal consequences [3-6]. The incidence of bile duct injury during laparoscopic cholecystectomy ranges from 0.1% to 0.6%, while overall surgical complications range from 0.5% to 6%. Most injuries occur due to misidentification of biliary anatomy during Calot's triangle dissection [7-10]. Therefore, identifying reliable anatomical landmarks remains essential for ensuring safe surgery. Rouviere's sulcus is a cleft located on the right lobe of the liver extending anterior to the caudate process. Described by Henri Rouviere in 1924, it corresponds approximately to the plane of the common bile duct. Since the cystic duct and artery usually lie anterior to this sulcus, maintaining dissection above this landmark minimizes the risk of biliary and vascular injuries. Several studies have demonstrated that the routine identification of Rouviere's sulcus improves surgical orientation, facilitates achievement of the Critical View of Safety, and significantly decreases bile duct injury rates. However, the visibility of the sulcus varies due to anatomical differences, inflammation, fibrosis, or adhesions. Evidence regarding its clinical significance in Indian patients remains limited. The present study was undertaken to evaluate the visibility of Rouviere's sulcus and determine its association with operative duration, postoperative hospital stay, and intraoperative complications in patients undergoing laparoscopic cholecystectomy.

Knowing the anatomy and identifying the structures correctly, to get to the right plane of dissection and proper clip placement, can bring down the incidence of bile duct injury and vasculobiliary injury. Many landmarks have been proposed as intraoperative references, among them Rouviere's sulcus is the classic landmark which is thought to indicate the plane of common bile duct [11-14].

In 1924, MH Rouviere, a French surgeon, described a fissure that is 2 to 5 centimetres long running to the right of the liver hilum and anterior to the caudate lobe [3]. Rouviere's sulcus is also known as *gans incisura* or *incisura hepatica dextra* [5].

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of General Surgery at King George Hospital over a period of seven months, from **March 2024 to October 2024**. The study aimed to evaluate the relevance of **Rouviere's sulcus (RS)** as an anatomical landmark during laparoscopic cholecystectomy and its association with operative time, perioperative complications, and duration of postoperative hospital stay.

Study Design and Setting

A hospital-based retrospective observational study was performed after reviewing the medical records and operative notes of patients who underwent elective laparoscopic cholecystectomy during the study period. Data regarding demographic characteristics, intraoperative findings, visibility of Rouviere's sulcus, operative details, and postoperative outcomes were collected using a predesigned data collection proforma.

Study Population

A total of **250 consecutive patients** fulfilling the eligibility criteria were included in the study.

Inclusion Criteria

- Patients aged **≥16 years**.
- Patients diagnosed with **uncomplicated symptomatic gallstone disease**.
- Patients who underwent elective laparoscopic cholecystectomy during the study period.

Exclusion Criteria

- Patients aged **<16 years**.
- Patients with complicated gallstone disease (acute cholecystitis, empyema, perforated gallbladder, gallbladder malignancy, or choledocholithiasis).
- Patients unfit for general anaesthesia.
- Patients who underwent planned open cholecystectomy or conversion to open surgery for reasons unrelated to Rouviere's sulcus.

Sample Size

The sample size was calculated using **Cochran's formula** with a **95% confidence interval** and **90% study power**, based on previously published literature. Although the minimum required sample size was 198 patients, all **250 eligible patients** encountered during the study period were included to improve the study power and precision of the results.

Surgical Procedure

All patients underwent standard **four-port laparoscopic cholecystectomy** under general anaesthesia. After pneumoperitoneum creation and appropriate traction of the gallbladder, the operating surgeon assessed the presence and visibility of **Rouviere's sulcus**. Patients were categorized into three groups:

- **Group I:** Rouviere's sulcus visible immediately after port placement and gallbladder traction.
- **Group II:** Rouviere's sulcus visualized only after release of omental or bowel adhesions.

- **Group III:** Rouviere's sulcus absent despite adequate exposure.

Dissection of Calot's triangle was performed while maintaining the plane above Rouviere's sulcus whenever identifiable, in accordance with the principles of safe laparoscopic cholecystectomy.

Current evidence supports the use of Rouviere's sulcus as an important extrabiliary landmark for reducing bile duct injury during laparoscopic cholecystectomy.

Outcome Measures

The primary outcome measures included:

- Visibility of Rouviere's sulcus.
- Bile duct injury.
- Vasculobiliary injury.
- Bowel injury.
- Gallbladder fossa collection.
- Port-site hematoma.
- Surgical site infection (SSI).

Secondary outcome measures included:

- Operative time (minutes).
- Duration of postoperative hospital stay (days).

Statistical Analysis

Data were entered into **Microsoft Excel** and analyzed using **IBM SPSS Statistics** software. Continuous variables were expressed as **mean ± standard deviation (SD)**, while categorical variables were expressed as frequencies and percentages. Differences among study groups were analyzed using **one-way Analysis of Variance (ANOVA)** followed by **Bonferroni post-hoc correction** for multiple comparisons. A **p-value <0.05** was considered statistically significant.

AIM

To find the association of rouvieres sulcus with the incidence of complications and other comorbidities.

OBJECTIVES

The association of rouvieres sulcus with incidence of complication such as build duct injury, vasculobiliary injury and port site infection or hematoma occurring within 2 weeks of surgery.

Participants and Methods in the clinical study:

This is a retrospective observational study, in single institution based setting. The study duration was 7 months (March to October 2024).

Inclusion criteria:

All patients of age more than or equal to 16 years with uncomplicated gallstone disease who underwent laparoscopic cholecystectomy at King George hospital were included in the study.

Exclusion criteria:

All patients below the age of 16 years.

Those with complicated gall stone disease.

Patients not fit for general anaesthesia.

Patients willing to undergo open cholecystectomy.

Sample size calculation:

Few studies on similar topics are available in literature. Study by Dahmane et al. is taken as the reference study.^[4] Cochran's formula was used with CI of 95% and power of 90%.

$$N = (Z^2 * p * q) / L * L$$

By adding 20% to the sample size for non response error, a total of 198 patients would have been adequate for this study. However during the study 250 patients were encountered fulfilling the inclusion criteria and were all enrolled into the study.

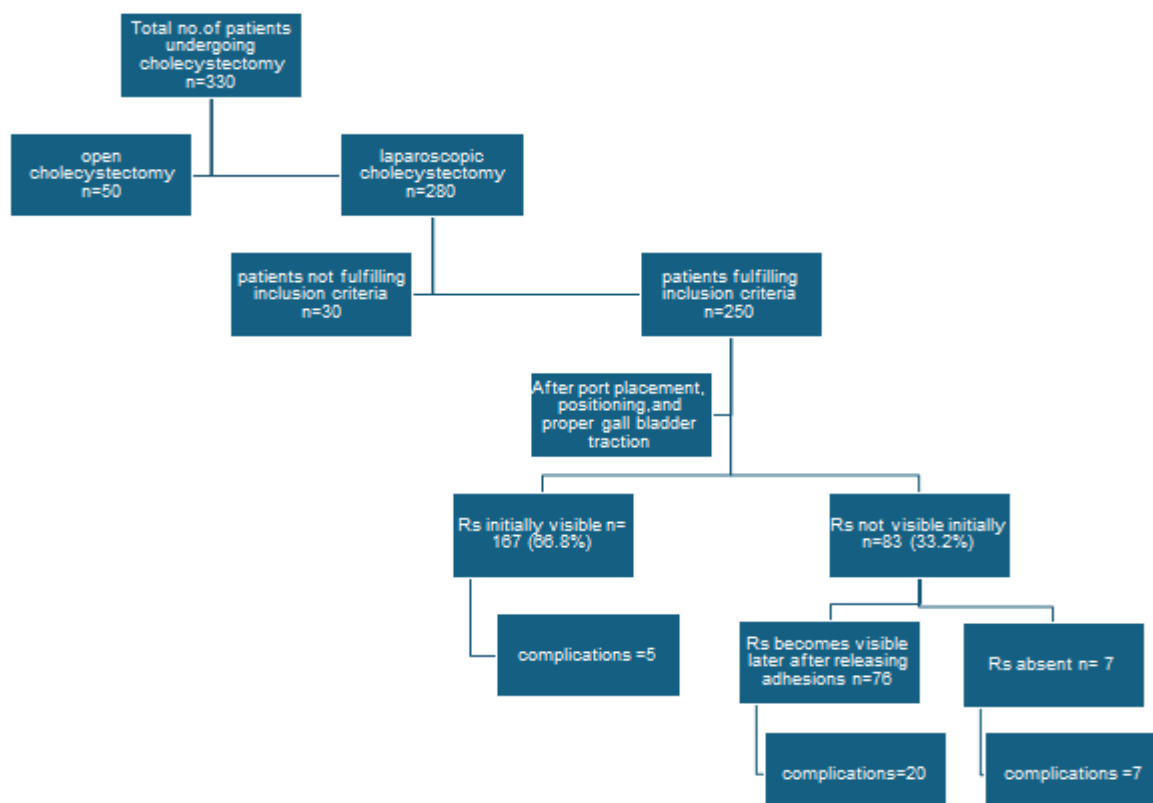
Enrollment of patients

All patients of age more than or equal to 16 years with uncomplicated gallstone disease who underwent laparoscopic cholecystectomy at King George hospital from March to October of 2024 were enrolled in the study. Detailed clinical history was taken from the participants in a preset proforma, ultrasonography of abdomen and pelvis along with all the

investigations that are required for assessing fitness for general anaesthesia were performed. All patients were screened for any exclusion criteria and were excluded accordingly. Informed consent was taken and they were all posted for elective laparoscopic cholecystectomy. Rouvieres sulcus was visualised in most of the participants, if initially it was not visible, any omental and bowel adhesions were cleared and rouviere's sulcus became visible. In very few of the patients rouvieres sulcus was not visualised. In all the cases any complications intraoperatively such as bile duct injuries, vasculobiliary injuries, port site infections and serous or serosanguinous collections in GB fossa and any other complications within 2 weeks post operatively were noted. Operative times and duration of hospital stay were noted and data was analysed by entering in Microsoft Excel and was analysed using spss. Patient data was analysed using ANOVA analysis and Bonferroni correction to compare categorical data. AP value of less than 0.05 is considered statistically significant.

RESULTS

A total of 250 patients were enrolled in the study. Overall findings of the study are as follows.



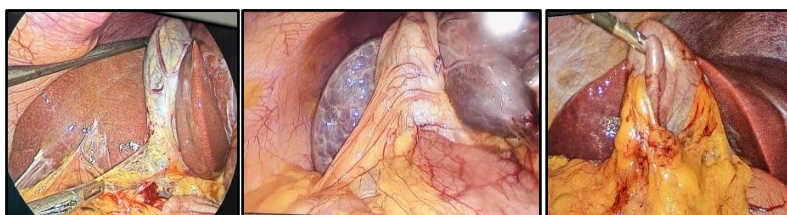
Age distribution

The age of the patients enrolled in the study ranged from 16 to 95 years. The majority were 35 to 45 years of age.

Gender distribution – In this study there were 90 (36%) males and 160 females (64%).

Visibility of rouvieres sulcus

After port placement, positioning, and proper traction of gall bladder, rouvieres sulcus was initially visible to the operating surgeons in 167 cases (66.8%) and in 83 cases (33.2%) rouvieres sulcus was not visualised initially. The reasons for initial invisibility of rouvieres sulcus were omental or bowel adhesions or its absence. The omental and bowel adhesions are seen in 76 cases and absence of rouvieres sulcus was observed in 7 cases.



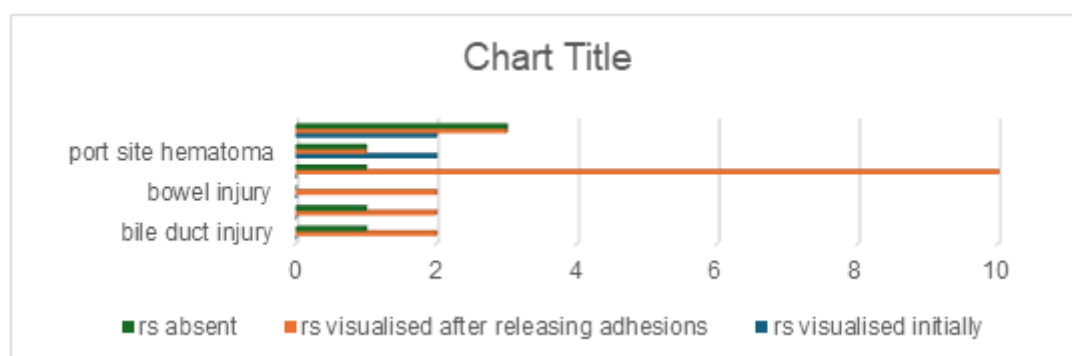
Intraoperative and complications

Omental and bowel adhesions obscuring visibility of rouviers sulcus

postoperative

Major complications studied here are bile duct injury, vascular injury and bowel injury. Minor complications are gall bladder fossa collections, port site hematomas and port site surgical site infections.

	BILE DUCT INJURY	VASCULO BILIARY INJURY	BOWEL INJURY	GALL BLADDER FOSSA COLLECTIONS	PORT SITE HEMATOMA	SURGICAL SITE INFECTIONS
RS VISUALISED INITIALLY	1	0	0	0	2	2
RS VISUALISED AFTER RELEASING ADHESIONS	2	2	2	10	1	3
RS ABSENT	1	1	0	1	1	3



Operative time and rouvieres sulcus

The mean, standard deviation values, ANOVA and Bonferroni correction for operative time in the rouvieres sulcus visible initially, rouvieres sulcus visible after releasing adhesions and the rouvieres sulcus absent groups were as follows.

group	mean	standard deviation
rouvieres sulcus visualised initially	38.86 minutes	13.95 minutes
rouvieres sulcus visualised after releasing adhesions	84.89 minutes	45.30 minutes
rouvieres sulcus absent	90.71 minutes	55.71 minutes

POST HOC TEST-BONFERRONI CORRECTION		
GROUPS	P VALUE BY T TEST	SIGNIFICANT?
ROUVIERES SULCUS VISUALISED INITIALLY V/S ROUVIERES SULCUS VISUALISED AFTER DISSECTION	4.36E-13	yes
ROUVIERES SULCUS VISUALISED AFTER DISSECTION V/S ROUVIERES SULCUS ABSENT	0.81	no
ROUVIERES SULCUS VISUALISED INITIALLY V/S ROUVIERES SULCUS ABSENT	0.06	no

ALFA VALUES	
test	alfa
anova	0.05
bonferroni corrected	0.01666667

Duration of hospital stay post operatively and rouvieres sulcus

The mean, standard deviation values, ANOVA and Bonferroni correction for the duration of hospital stay postoperatively in the rouvieres sulcus visualised initially, rouvieres sulcus visualised after release of adhesions and rouvieres sulcus absent groups are as follows.

	average	standard deviation
Rouvieres sulcus visulised initially	3.75	1.30
Rouvieres sulcus visualised after release of adeshions	5.74	1.67
Rouvieres sulcus absent	4.43	2.13

POST HOC TEST- BONFERRONI CORRECTION		
GROUPS	P VALUE BY T TEST	SIGNIFICANT?
ROUVIERES SULCUS VISUALISED INITIALLY (3.7) V/S ROUVIERES SULCUS VISUALISED FTER DISSECTION(5.7)	2.42E-15	yes
ROUVIERES SULCUS VISUALISED AFTER DISSECTION (5.7)V/S ROUVIERES SULCUS ABSENT(4.4)	0.19	no
ROUVIERES SULCUS VISUALISED INITIALLY(3.7) V/S ROUVIERES SULCUS ABSENT(4.4)	0.47	no
ALFA VALUES		
test	alfa	
anova	0.05	
bonferroni corrected	0.01666667	

DISCUSSION

In cases where there are no adhesions and inflammation, rouvieres sulcus if present is visualised very clearly during laparoscopic cholecystectomy due to pressure of carbon dioxide insufflation opening up the sulcus widely and enhanced illumination.

The mean age of patients in the study is 43 years. The majority of participants in the study were in the range of 35 to 45 years. In the study by Sachdeva et al. the mean age was 41.5 +/- 15.4 years.^[6] This suggests a shift in the trend in gall bladder diseases from middle to young age.

Females have a higher preponderance of gall stone disease. Female to male ratio is 1.78:1 showing sex hormone predilection. In a study by Sachdev et al., females have higher preponderance of gall stone disease with female to male ratio of 1.56:1.^[6] This supports the claim that estrogen increases biliary cholesterol secretion causing supersaturation of bile.

The present study demonstrated that Rouviere's sulcus was identifiable in 97.2% of patients either initially or after adhesiolysis, emphasizing its importance as a consistent surgical landmark. Patients in whom the sulcus was identified immediately experienced significantly fewer intraoperative complications and substantially shorter operative times than those requiring adhesiolysis. These findings support the concept that early recognition of Rouviere's sulcus facilitates safe dissection and improves surgical efficiency.

Our study observed a mean patient age of 43 years with female predominance (64%), reflecting the established epidemiology of gallstone disease due to hormonal influences. Similar demographic characteristics have been reported in recent international studies evaluating laparoscopic cholecystectomy outcomes.

The overall incidence of bile duct injury was low, and most complications occurred in patients with obscured anatomy due to adhesions. Adhesiolysis increased operative complexity, resulting in longer surgical duration and increased postoperative morbidity. These observations emphasize the importance of careful anatomical identification before Calot's triangle dissection.

The incidence of surgical site infection (SSI) in the present study was low and was predominantly observed in patients where Rouviere's sulcus was obscured by adhesions or absent. Difficult dissection and prolonged operative duration may increase tissue handling and contamination, thereby predisposing patients to SSI. Similar findings were reported by **Singh et al. (2024)**, with **Afaq N** as a co-author, who found that prolonged surgery, wound contamination, diabetes, and obesity were significant risk factors for postoperative SSI and emphasized strict infection prevention practices to reduce SSI rates.^[15]

Mascagni et al. (2021) conducted a prospective video-based assessment of 343 laparoscopic cholecystectomy procedures to evaluate the implementation of the Critical View of Safety (CVS) during gallbladder surgery. The study demonstrated that consistent identification of anatomical landmarks, including Rouviere's sulcus, together with proper achievement of the Critical View of Safety, significantly improved the quality of dissection, reduced the risk of bile duct injury, and enhanced overall operative safety. The authors recommended routine identification of Rouviere's sulcus as an important anatomical landmark during laparoscopic cholecystectomy to minimize biliary complications.

Overall, our findings agree with both classical and contemporary evidence that Rouviere's sulcus serves as a dependable extra-biliary landmark for safe laparoscopic cholecystectomy and should be identified whenever feasible.

COMPLICATIONS

In rouvieres sulcus visible initially group, 1major and 4minor complications were present. In rouvieres sulcus visible after release of adhesions group, 6 major and 14 minor complications were seen. In rouvieres sulcus absent group, 2 major and 4 minor complications were seen.

This difference in occurrence of complications is clinically significant and this data implies that the initial recognition of rouvieres sulcus in laparoscopic cholecystectomy can avoid major complications. Hugh et al. and Zubair et al. had shown minimal common bile duct injury during laparoscopic cholecystectomy by beginning the dissection ventral to the rouvieres sulcus.^{[7][8]}

The incidence of bile duct injury, vascular biliary injury, bowel injury and minor complications in the study are as follows 1.6%, 1.2%, 0.8%, and 9.2% respectively.

OPERATIVE TIMES

Average of operative times in rouvieres sulcus visualised initially, in rouvieres sulcus visualised after releasing adhesions and in rouvieres sulcus absent groups are 39 minutes, 85 minutes, and 91 minutes respectively. If the rouvieres sulcus is visualised initially then the operative time markedly comes down by 57% when compared to rouvieres sulcus absent group and 46% when compared to rouvieres sulcus visualised after release of adhesions group.

The results after post hoc analysis suggest that if the rouvieres sulcus is visualised initially then the operative times are significantly decreased and if the rouvieres sulcus is absent there is no much difference in the operative times when compared to the other 2 groups. This is because in the rouvieres sulcus visualised initially group no time would have been spent in adhesion release and the operating surgeons might not have had any preoccupied hesitation regarding the chance of CBD injury as rouvieres sulcus marks the plane of CBD. But whenever there were adhesions and rouvieres sulcus could not be visualised, releasing of these adhesions in order to visualise the rouvieres sulcus and identify the plane of CBD consumed most of the operating time. In subjects where rouvieres sulcus was absent finding other landmarks such as critical view of safety and cystic plane consumed most of the time, if these landmarks could be identified initially then operative time was significantly reduced.

DURATION OF HOSPITAL STAY AND ROUVIERES SULCUS

Average of the duration of hospital stay postoperatively in days in the rouvieres sulcus visualised initially, rouvieres sulcus visualised after release of adhesions, and in rouvieres sulcus absent groups are 4, 6 and 4 days respectively,

The post hoc analysis showed that the duration of hospital stay in the rouvieres sulcus visible initially group was significantly less than that in rouvieres sulcus visualised after release of adhesions group. This could be due to shorter operative times, lesser dissection and lesser need to place a drain in this group. As majority of the patients in the study with the drain had tendency towards going home only after removal of drain. There is no much difference in the duration of hospital stay between the rouvieres sulcus absent group and the other 2 groups.

SUMMARY

In rouvieres sulcus visible initially group only 1 major and 4 minor complications were present, this is because operating surgeons might not have had any preoccupied hesitation regarding the chance of CBD injury as rouvieres sulcus marks the plane of CBD. In rouvieres sulcus visible after release of adhesions group, 6 major and 14 minor complications were seen. In rouvieres sulcus absent group 2 major and 4 minor complications were seen.

The mean and standard deviation values for operative times and duration of hospital stay in rouvieres sulcus visualised initially group, are 38.9 +/-14.9 mins and 3.7 +/-1.3 days, and that of rouvieres sulcus visualised after release of adhesions group, is 84.9 +/-45.3 mins and 5.7 +/-1.7 days and that of rouvieres sulcus absent group, is 90.7 +/-55.7 mins and 4.4 +/-2.1 days respectively.

CONCLUSION

According to our study, recognition of rouvieres sulcus initially during laparoscopic cholecystectomy avoids major complications and is associated with shorter operative time as well as shorter duration of hospitals stay but there is no role of releasing adhesions and doing additional dissection in order to view rouvieres sulcus as it increases the chances of major complications, increases the operative times and thereby increases the duration of hospital stay post operatively. Whenever rouvieres sulcus is absent, other landmarks for CBD play an important role.

This study has few limitations like small sample size, different surgeons with different experience, short term follow ups, observational bias, and being single centre based study.

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Conflict of Interest: The authors declare no conflict of interest.

Ethical Approval: Not applicable (review article).

Consent for Publication: Not applicable.

Author Contributions: All authors contributed equally to conceptualization, literature review, drafting, and final approval of the manuscript.

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