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Cross-sectional Study

Rouviere's sulcus - An anatomical landmark for safe laparoscopic cholecystectomy: A cross-sectional study

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ABSTRACT

Introduction: Laparoscopic cholecystectomy (LC) has been established as the gold standard treatment for symptomatic gallstones, however surgeons face the risk of injuring bile ducts and vessels due to the inherent limitations of laparoscopy.

Methods: This is a cross-sectional study done in the Department of Surgery, Shree Birendra Hospital (SBH) on patients who were posted for LC. The study period was through April 2021 to September 2021. During LC, the anatomy of RS was noted and classified into Group A (RS present) or Group B (RS absent). Data analyses were performed considering a p-value of <0.05 as statistically significant.

Results: RS was present in 169 (93.9%) out of 180 cases. The open sulcus type was found in 114 cases (67.5%), followed by closed type in 26 (15.4%), slit sulcus type in 22 (13.0%), and scar type in 7 (4.1%) cases. Injury to cystic artery occurred in one case (0.15%) of Group A while in two cases (18.18%) of Group B (p-value = 0.001). The adjusted operative time in Group A and Group B were 50.61 ± 10.33 min and 69.86 ± 15.28 min respectively (p-value = 0.005). There was significant difference between Group A and Group B in conversion to open surgery - 01 (0.59%) and 04 (36%) respectively (p-value < 0.001). Surgical Site Infection (SSI) was detected in nine (5.33%) cases among Group A and in three (27.2%) cases among Group B (p-value = 0.028).

Conclusion: RS can be considered as an important anatomical landmark for safer LC with fewer injuries to cystic artery, SSI, conversion to open surgery and shorter operative time.

1. Introduction

Laparoscopic cholecystectomy (LC) was first performed by Professor Erich Mühe of Germany, on September 12, 1985 [1], and has now become one of the most common surgical procedures worldwide [1]. LC has been the gold standard treatment for gallstone disease. However, in the 1990s, LC had a higher incidence of surgery related complications than conventional open laparoscopy [2,3]. The complications ranged from bile duct injury (0.6%), vascular injury (0.14%) to bowel injury (0.25%) [2,3]. The most feared complication of this surgery is injury to the bile ducts or hepatic arteries. It is clear that as the numbers of laparoscopic cholecystectomies increased over time, so did the rates of associated bile duct injuries, even when performed by experienced surgeons [4,5]. Given the serious nature of this complication, the surgeon must make every effort to minimize the risk of bile duct injury.

Accurate identification of the hepatobiliary anatomy is critical for a safe LC. Most bile duct injuries are thought to occur as a result of misidentification of biliary anatomy due to misinterpretation and/or lack of understanding the anatomy. A safe cholecystectomy is one that is "safe for both the patient (no bile duct/hollow viscus/vascular injury) and for the operating surgeon (no or minimal scope for litigation)" [5,6]. A common landmark or reference point being increasingly described in recent reports is the Rouviere's sulcus (RS) [7]. This sulcus, which was hardly seen or described in the open surgery era, is appreciated very clearly during LC due to the pressure of CO_2 insufflation opening up the sulcus widely along with the enhanced illumination and image quality of digital endoscopic cameras used nowadays [8].

In 1924, M.H. Rouviere, a French surgeon, described a fissure that

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now bears his name. Rouviere's sulcus is a 2–5 cm long sulcus running to the right of the liver hilum and anterior to the caudate lobe [9,10]. It contains the right portal triad or its branches. The sulcus accurately identifies the plane of common bile duct, a fact substantiated by cholangiographic studies [11,13]. It can be identified in up to 80% of cases [11,13]. In 1997, Hugh et al. suggested that Rouviere's sulcus was a useful anatomic landmark in LC [11,13].

This study is being performed to determine the frequency of demonstrable Rouviere's sulcus as well as to assess safe laparoscopic surgery in its presence.

2. Methods

2.1. Registration

The manuscript has been reported in line with the STROCSS criteria [12]. It has also been registered with Research Registry at on January 4, 2022 and the unique identifying number is researchregistry7509.

2.2. Ethical approval

The Institutional Review Committee of NAIHS approved the study with registration number 414. All the participants were informed about the study and its objectives before the data collection. A consent form was incorporated into the questionnaire itself. Written informed consent was obtained from all individual participants who took part in the study.

2.3. Participants and study design

This study was a single hospital-based prospective observational study at a 750-bed tertiary care center, Shree Birendra Hospital (SBH), Nepal. It was conducted for a period of six months (April to September 2021). Probable participants were patients of the age group above 18 years undergoing LC at SBH. The exclusion criteria were: age <18 years, patients willing to undergo an open cholecystectomy, patients unfit for general anesthesia, and patients with complicated gallstone disease, liver disease, malignancy of gallbladder or HIV/immunocompromised state.

2.4. Study procedure

All the study participants were informed about their rights, along with the study methods and contexts relating with the prognosis. The patients were prepared for surgery following a detailed clinical history, a thorough clinical examination and consent for the study. Confirmation of presence of RS was noted by the surgeon prior to initiation of the surgery after port placement and insufflation of carbon dioxide (CO_2) intraoperatively. Based on presence of RS, patients were divided into two groups – Group A (RS present) and Group B (RS absent).

In Group A patients, RS characteristics were categorized into four types [13] in terms of its type. Type I (Open sulcus type) is defined as a cleft in which the right hepatic pedicle is visualized and the sulcus is open throughout its length. Type II (Closed sulcus type) is partially fused sulcus which opens only at its lateral end while Type III (Slit sulcus type) is also partially fused but it opens only at its medial end. In Type IV (Scar type) the pedicle is visualized as a scar or an absent sulcus. If RS was not visible, the likely reason noted was bowel adhesion, caudate lobe liver disturbance, omental adhesion or complete absence of RS (Group B).

Among all patients who underwent LC, their duration of surgery, intraoperative and post-operative complications, conversion of laparoscopic to open surgery and length of hospital stay (LOS) were noted in a predesigned proforma. Bile duct injury (identified intraoperatively or postoperatively within two weeks) or any major vascular injury that occurred during the surgery was considered as a major complication, while other complications such as port site hematoma, surgical site infection (SSI), spillage of gallstone and biloma in gallbladder fossa were considered as minor complications.

2.5. Statistical analysis

After the data collection, collected data were edited, classified and coded. The coded data were entered and tabulated using the Statistical Package for Social Science (SPSS) version 25. Descriptive statistics included mean, standard deviation for quantitative variable, number and percentage for categorical data. Since our data was not normally distributed, we used non-parametric tests to find associations among different variables, between the two groups. We used Mann Whitney *U* test to compare the medians of the two groups for variables with interval scale data and Chi-square test to compare variables having categorical data. A p-value < 0.05 was considered to be significant.

3. Results

A total of 180 cases were obtained in the six-month study period. The age of the patients ranged from 23 to 74 years with a mean age of 39.85 ± 13.58 years. In this study, there were 64 (35.6%) males and 116 (64.4%) females with female preponderance of gallstone disease of 1:1.81. Among these patients, majority of the patient underwent LC for symptomatic gall stone disease and had presented to emergency department once or twice prior to surgery (Table 1). The mean Body Mass Index (BMI) was found to be 25.645 ± 2.86 kg/m^2.

Following port placement, CO_2 insufflation and proper traction of the gallbladder, RS was present in 169 (93.9%) cases **(Group A).** Among Group A, 149 (88.2%) cases had easy RS visibility. However, RS was not initially visible in 20 (11.8%) cases due to omental adhesion in 17 (85%) cases and omentum-bowel adhesion in 3 (15%) cases. Complete absence of RS (**Group B**) was noted in 11 (6.1%) cases of our study. Categorization of type of sulcus among Group A showed open sulcus type in 114 (67.4%), closed sulcus type in 26 (15.3%), slit type in 22 (13%), and scar type in 7 (4.1%) cases respectively (Table 2).

The mean values for operative time in Group A and Group B were 51.20 ± 12.87 min and 94.90 ± 36.87 min respectively (p-value < 0.001). Since, four (36%) of the LC cases among Group B and only one (0.59%) case among Group A were converted to open surgery, additional analysis was done excluding converted cases in both groups. The operative time after adjustment in Group A and Group B were 50.61 ± 10.33 min and 69.86 ± 15.28 min respectively (p-value = 0.005). Among the participants, 80.6% were discharged within 24 h of operation. The mean discharge duration of Group A and Group B were 1.18 ± 0.52 days and 2.9 ± 2.16 days respectively (p-value <0.001).

Regarding complications, a total of five cases were converted from laparoscopic to open cholecystectomy; three cases of uncontrolled bleeding due to cystic artery injury and two cases of severe adhesions.

Table 1
Demographic and clinical profile of the patients who underwent Laparoscopic Cholecystectomy.

S. no	Variables	n (%) [Total: 180]
1.	**Age:** mean ± SD*	39.85 ± 13.58
2.	**Sex:**	
	Male	64 (35.6%)
	Female	116 (64.4%)
	Male: Female Ratio	1:1.81
3.	**Clinical presentation:**	
	Symptomatic gall stone disease	139 (77.2%)
	Gall bladder polyp	16 (9%)
	Acute mild biliary pancreatitis	11 (6.1%)
	Acute cholecystitis	7 (4.2%)
	Post-ERCP[a]	7 (4.2%)
4.	**BMI[b]:** mean ± SD*	25.645 ± 2.86

[a]ERCP: Endoscopic retrograde cholangiopancreatography; [b]BMI: Body Mass Index (BMI).
SD*: Standard Deviation.

Table 2
Characteristics of Rouviere's sulcus among patients who underwent laparoscopic cholecystectomy (LC).

S. no	Patients who under LC (N = 180)			Test value	p-value
	Characteristics	Group A (RS present) n (%)	Group B (RS absent) n (%)		
1.	Rouviere's sulcus presence	169 (93.9%)	11 (6.1%)	–	–
2.	Rouviere's sulcus type • Type I: Open •Type II: Closed •Type III: Slit •Type IV: Scar	114 (67.5%) 26 (15.4%) 22 (13%) 7 (4.1%)	–	–	–
3.	Operative time: mean ± SD*	51.20 ± 12.87	94.90 ± 36.87	231.5[#]	<0.001
4.	Operative time (after adjustment)[a]: mean ± SD*	50.61 ± 10.33	69.86 ± 15.28	220.5[#]	0.005
5.	Conversion to open surgery	01 (0.59%)	04 (36%)	36.58[$]	<0.001
6.	Discharge day: mean ± SD*	1.18 ± 0.52	2.9 ± 2.16	440.5[#]	<0.001

SD*: Standard Deviation; [#]: Mann-Whitney *U* test; [$]: Chi square test; [a]: excluding cases converted to open surgery.

There was significant difference between Group A and Group B in conversion to open surgery - 01 (0.59%) and 04 (36%) respectively with a p-value of <0.001. Among Group A, there was one (0.59%) case of cystic artery injury that led to uncontrolled bleeding, while Group B had two (18.18%) such cases with a significant difference (p-value = 0.001). However, no major bile duct injuries were reported in their intra-operative or postoperative follow-up. Additionally, no injury to the adjacent organ were noted during the study.

Among Group A, SSI was detected in nine (5.33%) cases, while Group B had three (27.2%) cases of SSI (Table 3) which was statistically significant (p-value: 0.028). They were treated with antibiotics and daily dressing. Biloma was reported in five cases during follow-up of the participants, however, none of them required surgical intervention and were treated with antibiotics.

4. Discussion

Laparoscopic cholecystectomy (LC) is the most commonly performed laparoscopic surgery worldwide [13]. The insurgence of minimally invasive surgery in almost all available surgeries has made complications unavoidable unless done with precaution. In the present era, LC has common complications like bile duct injuries and hemorrhage, which range between 0.3 and 1% [13]. RS is easily and clearly visible during cholecystectomy as a guiding point. Secondly, common bile duct is present at the level of Rouviere's sulcus [11]. The Rouviere's sulcus (RS) thus can be used as a safe anatomical landmark that is present on the hilar surface of liver [13]. So, it is pertinent to know more about the anatomical details and its frequency in the population [14].

In our study, the RS was present in 169 (93.9%) and absent in 11 (6.1%) of the patients undergoing LC. Earlier studies have shown that RS is usually seen in majority of population during LC compared to open surgery [10–14]. Dahmane et al. [13] who reported that Rouviere's sulcus was present in 82% of normal livers, and open RS was the commonest among them. These findings were similar to our study which showed open type of RS was the commonest (114 cases; 67.4%) among patient with visible RS.

The mean operative duration among patients undergoing LC in our study was found to be less among Group A (RS present) with a mean of 51.20 ± 12.87 min compared to Group B (RS absent) (94.90 ± 36.87 min), which was statistically significant (p-value < 0.001). This is probably due to the need for conversion to open surgery in four of the eleven (36.4%) patients among Group B. Hence, additional analysis was done excluding converted cases in both groups. The operative time after adjustment in Group A and Group B were 50.61 ± 10.33 min and 69.86 ± 15.28 min respectively (p-value = 0.005). This highlights how the presence of RS aids in performing LCs and shortening the operative time. Similar findings were noted in a study of 230 cases conducted by Kumar A et al. [16] in Nepal which showed decreased mean operative time among patients with RS visibility compared to those with non-visibility of RS (p-value <0.05).

In our study, injury to the cystic artery leading to uncontrolled bleeding occurred in one case (0.15%) of the RS present group and in two cases (18.18%) of the RS absent group which was a statistically significant difference (p-value = 0.001). The visibility of RS has been considered as an important predictor in correlation with decrease in complications such as bile duct injury, major vessel injury and injury to the adjacent organ by few other studies [10–15]. Few other minor complications such as SSI, biloma and port site hematoma were noted among both group of patients but were managed conservatively.

Other safety measures such as identification, Critical View of Safety (CVS) before Calot's dissection, SAGES safety protocols are proposed in order to reduce the risk of bile duct injury, including routine use of intraoperative cholangiography [17–19]. RS can always be taken as a landmark for performing safe LC [13] in consideration with other safety measures.

Table 3
Comparison of complications among the patients with and without visibility of RS.

Complications	RS present n (%) [Total: 169]	RS absent n (%) [Total: 11]	p-value
Major			
1. **CBD[a] injury**	None	None	–
2. **Injury to cystic artery (with uncontrolled bleeding)**	01 (0.59%)	02 (18.18%)	0.001[b]
3. **Conversion to open surgery**	01 (0.59%)	04 (36.36%)	<0.001[b]
4. **Injury to adjacent organ**	None	None	–
Minor			
1.Port site hematoma	11 (6.50%)	2 (18.18%)	0.396[b]
2.Surgical site infection	09 (5.33%)	03 (27.27%)	0.028[b]
3.Biloma	03 (17.75%)	02 (18.18%)	0.093[b]

[a] CBD: Common Bile Duct.
[b] Chi square test.

4.1. Study limitations

The study was self-funded and could only be conducted in a single hospital for a short duration of time. It is possible that a degree of unintentional selection bias occurred due to the small sample size. Since this study was conducted in a military hospital whose patients are mostly army personnel and their families, its results may not be representative of the general population. Follow-up studies conducted in multiple centers with larger sample size will help obtain broader perspectives on the role of RS in safe LC.

5. Conclusion

Rouviere's Sulcus (RS) can be considered as an important anatomical landmark by surgeons to perform safe laparoscopic cholecystectomy. This study showed that presence of RS leads to fewer rates of injury to cystic artery, conversion to open surgery, SSI and shorter operative time.

Ethical approval

Approved by the Institutional Review Board from Nepalese Army Institute of Health Sciences (NAIHS) (IRC NAIHS/Reg. No. 414).

Ethics statement

All procedures performed in studies involving human participants were by the ethical standards of the Health Research Ethics Committee.

Registration of research studies

1. Name of the registry: Research Registry (http://www.researchregistry.com).
2. Unique Identifying number or registration ID: researchregistry7509.
3 Hyperlink to your specific registration: https://www.researchregistry.com/browse-the-registry#home/registrationdetails/61d45a38e6c159001e1203dd/

Funding

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Consent

Informed consent was obtained from all individual participants who took part in the study.

Data availability

Data will be made available on request.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Conflicts of interest

No any conflict of interest.

Sources of funding for your research

None.

Ethical approval

Approved by the Institutional Review Board from Nepalese Army Institute of Health Sciences (NAIHS) (IRC NAIHS/Reg. No. 414).

Consent

Informed consent was obtained from all individual participants who took part in the study.

Author contribution

Sunil Basukala (SB) and Narayan Thapa: Conceptualization, Supervision SB, Bikash Bahadur Rayamajhi, Dhirendra Ayer and Saurav Karki: Investigation, Data Curation Subodh Dhakal (SD), Kunda Bikram Shah and Bikram Basukala: Formal Analysis SB and Ayush Tamang (AT) = Visualization, Writing - Original Draft, SB, AT, SD, Shriya Sharma = Writing - Review and Editing All the authors read and approved the final manuscript.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.103404.

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