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Rouviere's Sulcus: Frequency and Types among Patients presented to Wad Madani Teaching Hospital for Laparoscopic Cholecystectomy; Gezira State; Sudan

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Abstract

Scientific background: Laparoscopic cholecystectomy is the gold standard for surgical treatment of gallstones disease. **Method:** The study aimed to determine presence and types of Rouviere's sulcus along with its association with gender, and postoperative morbidity among Sudanese patients presented for laparoscopic cholecystectomy, and operated on at Wad Madani Teaching Hospital, Gezira State, Sudan; during the period from November 2022 to November 2023. It was a comparative cross-sectional study. Study population were patients of more than 18 years old; where total coverage of them (150) was done. Data was collected from files and records of patients presented there during study period. Master sheet was used for data collection. SPSS version 25.0 was used for analysis. P-value ≤ 0.05 was considered significant. **Results:** Age of participants ranged from 17 to 85 years, with a mean age of 47.57 (SD ± 15.14). Majority of them were female (93.3%). Gallstones were present in 99.3%. Rouviere's sulcus was identified intraoperatively among 92.7%. Identified sulcus type was: Open sulcus (54.0%), Close sulcus (27.3%), and Scar sulcus (11.3%). Postoperative operative outcomes: 95.3% experienced uneventful outcomes; and 4.7% experienced complications. Both postoperative complications and gender, had no statistical associations with the presence of Rouviere's sulcus; P-value = 0.470, and 0.112 respectively. Also, there was no significant statistical association between gender and sulcus type (P-value 0.301). **Conclusion and recommendations:** No significant statistical association between both postoperative complications and gender with the presence of Rouviere's sulcus, or between gender and sulcus type; was identified. Further study was highly recommended.

Keywords: Rouviere's Sulcus; Laparoscopic Cholecystectomy; Wad Madani Teaching Hospital; Gezira State; Sudan.

1. Introduction

Surgical anatomy has important impact on the safety of procedures. It has significant role in reducing postoperative complications. As most of the complications associated with misidentification and misrecognition of the anatomy especially in biliary surgery [1-5].

Cholelithiasis was first described by Antonio Benivenius in 1420. The first open cholecystectomy was performed by Carl Johann August Langenbuch, a German surgeon at the Lazarus Krankenhaus on July 15, 1882. On September 12, 1985, a German Professor Erich Mühe performed the first laparoscopic cholecystectomy. It's considered as gold standard for surgical treatment of gallstones disease, it becomes one of the common performed surgical procedures globally,

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whereas more than 750,000 cholecystectomies are accomplished in the USA every year. It has many advantages over open cholecystectomy including: rapid recovery, less pain and shorter hospital stay [1, 3-27].

Laparoscopic cholecystectomy is associated with higher risk of biliary tract injury when compared to open cholecystectomy. Bowel injury (0.25%), vascular injury (0.14%), and bile duct injury (0.6%) were among these complications. The primary cause of the biliary tract injury is misidentification of the biliary anatomy. This can occur in two ways: first, when the common bile duct (CBD) is mistaken for the cystic duct; second, but less common; when an abnormal right hepatic duct is mistaken for the cystic duct. This may be because the surgeon's perspective is essentially two-dimensional, despite the reality that biliary anatomy exists in three dimensions. Other causes related to biliary injury include bleeding, aberrant anatomy, infection or inflammation during acute cholecystitis, and inexperience of the surgeon [1, 3-25, 28].

Proper recognition of the hepatobiliary anatomy is mandatory for safe dissection during laparoscopic cholecystectomy as the major cause of the bile duct injuries is misidentification of this anatomy. As response for these complications surgeons developed many strategies to avoid it during the surgery. These strategies were created using careful dissection techniques, anatomical knowledge, and surgical attentiveness [1, 2, 5, 8, 9, 11, 15, 18, 19, 21, 23, 24, 25].

Three elements are seen to have had a significant impact on how the LC's technical strategies were developed: 1. The CVS, or critical view of safety; an altered dissecting area which replaced the old, poor infundibular approach. It consist of 3 main parts: dissecting fat and fibrous tissues at the triangle of Calot, dividing the gallbladder's lowest portion from the cystic plate, which is the flat fibrous surface to which the non-peritonealized side of the gallbladder is attached, and finally identifying the two, and only the two, structures that enter the gallbladder. The CVS is secured if all three requirements have been encountered. Nevertheless, CVS by itself is insufficient to avoid bile duct injuries (BDI) because up to 80% of BDIs happen when the surgeon is attempting to properly establish the crucial view. 2. Intraoperative delineation of biliary tracts: many methods are used to accomplish this, including endoscopic placement of an optical fiber in the CBD, methylene blue cholangiography, intraoperative cholangiography, and Olsen cholangiocatheter. The limitations of this method are that it is invasive and increases operative time. 3. Anatomical landmarks: The use of anatomical landmark helps the identification of the hepatobiliary anatomy. The 6 anatomical landmarks that are commonly used to guide gall bladder dissection are Rouviere's sulcus (RS), Hartmann's pouch, Mascagni lymph node, right hepatic artery, cystic artery, and Callot's triangle [2, 4, 16, 17, 18, 21, 24, 25, 26].

Rouviere’s sulcus (RS) is a crucial landmark to identify hepatobiliary anatomy during laparoscopic cholecystectomy. The right hepatic artery, right portal vein, and right hepatic bile duct branches are located inside this 2-4 cm long sulcus on the posterior surface of the liver, which runs to the right of the liver hilum and anterior to the caudate lobe. Henrie Rouviere initially describes it in 1924 under the term "sillon du processus caudé." It became known as "incisura dextra" by Gans in 1955, changed to "le sillon du processus caudé de Rouviere" by Couinaud in 1957, and used as "incisura dextra of Gans" in 1991. The French hepatobiliary surgeon Claude Couinaud proposed the current term, "Rouviere's sulcus" (RS) which is now recognized around the world. The morphology and length of RS might vary, in 97% of cases it lies obliquely to the anterior, inferior, and external edge of the liver, while in 3% of cases it lies horizontally. In almost 80% of cases, RS can accurately identify the common bile duct plane. Consequently, it is an important anatomical landmark that surgeons use to guide them during hepatobiliary procedures, particularly cholecystectomy. This is because it indicates the gallbladder's neck, thereby making it applicable to use it as a reference point in order to rapidly and safely identify the cystic duct and artery in Calot's triangle. Because the common bile duct is located beneath the Rouviere's sulcus and the cystic duct and artery lie above it, identifying the RS will help the surgeon recognize the superior extent of the CBD as a result, dissection above the plane of the RS will help prevent CBD injuries, even so, most of surgeons still do not practice it. Rouviere's sulcus is important anatomical landmark in laparoscopic cholecystectomy, according to Hugh et al.'s 1997 suggestion. Additionally, Peti and Moser noted that during laparoscopic cholecystectomies, Rouviere's sulcus can be identified as a crucial anatomical landmark to prevent injury to the bile duct. Until now there are no clear data in the anatomical literature described its morphology and its frequency. Reduced rates of bile duct injury, blood loss, and operating time have been linked to the use of RS as an anatomical marker in LC. In the literature, absent RS is reported in 10–30% of cases [1, 2, 4-19, 21-30].

RS is difficult to spot during open cholecystectomy, while it is clearly observable during LC because of the increased illumination and image clarity delivered by digital endoscopic cameras, as well as the pressure of CO2 insufflation, which opens up the sulcus broadly [4, 21, 26, 28].

Rouviere’s sulcus is classified according to the shape and the presence of the pedicle in its floor into: 1. The deep type, a cleft with measured length, width, and breadth through which the right hepatic pedicle branches flow through its floor, It is subdivided into 2 subtypes: fully open (open) which is open along its entire length, and partially open (closed);

which is only accessible at its lateral end and partially visible right hepatic pedicle. 2. The slit: Its length can be measured, but not its depth or breadth, which must be less than 5 mm. 3. Scar type: with or without the white line. The average length of RS is 3 cm; however, it can range from 1 to 5 cm. The average width is 1.1 cm and ranges from 0.5 to 2 cm. The average depth is 1.1 cm, with variations between 0.5 and 2 cm. There are 3 positions for RS: vertical, oblique, and horizontal. The most common position is horizontal, and the least common is vertical [1, 16, 21].

This study aimed to determine the presence and types of Rouviere's sulcus along with its association with the gender, as well with the postoperative morbidity among Sudanese patients presented with features of cholecystitis, diagnosed, and operated on at Wad Madani Teaching Hospital, Gezira State, Sudan; during the period from November 2022 to November 2023.

2. Material and methods

2.1. Study design

Observational, comparative cross-sectional, hospital-based study.

2.2. Study duration

The study was carried out during the period from November 2022 to November 2023.

2.3. Study area

The study was conducted at the Department of General Surgery, Wad Madani Teaching Hospital; Gezira State; Sudan. Wad Madani Teaching Hospital is a tertiary hospital that serves the whole Gezira State and nearby states. It is the main teaching hospital in Gezira State. It includes the Departments of Surgery, Medicine, ENT, Orthopedics, Radiology, Blood Bank, ICU, Referred Clinics, Medical Emergency Department, Surgical Emergency Department, Laboratory, and Operation Theatres.

2.4. Study population

Patients of more than 18 years old, presented with features of cholecystitis, the diagnosis was confirmed, and had been operated on at Wad Madani Teaching Hospital.

2.4.1. Inclusion criteria

All patients of more than 18 years old, admitted for elective laparoscopic cholecystectomy, and had been operated on, at Wad Madani Teaching Hospital, during the study period, and agreed to participate in the study.

2.4.2. Exclusion criteria

Patients scheduled for elective open cholecystectomy, Patients who refused to participate in the study, Patient <18 years old, and Incomplete medical records.

2.5. Study variables

Dependent variables: US findings (gall stones), intraoperative findings (Rouviere's sulcus), and postoperative complications.

Independent variables: Age, and gender.

2.6. Procedure

The surgical procedure performed was laparoscopic cholecystectomy under general anesthesia with endotracheal intubation using a standard 30 mm laparoscope and four operating ports (a 10 mm umbilical port and three 5mm ports). The three 5mm ports were inserted in the right subcostal area. The 5mm laparoscopic coagulation shears were used for Calot's triangle dissection and cystic artery and duct isolation. Cystic artery and duct were control and released after isolation using 5mm laparoscopic clips. After cholecystectomy, absorbable suture was used for closure of the fascia to prevent umbilical hernia, finally the skin was closed using prolene or nylon 2/0.

2.7. Data

2.7.1. Data types and sources

Study secondary data from files and records of patients presented with features of cholecystitis, diagnosed and operated on at the Department of General Surgery, Wad Madani Teaching Hospital; Gezira State; Sudan; during the study period.

2.7.2. Data collection tools

The data was collected by master sheet that covered the relevant variables.

2.8. Sampling: technique and size

Total coverage of all patients presented with features of cholecystitis, diagnosed and operated on at the Department of General Surgery, Wad Madani Teaching Hospital; Gezira State; Sudan; during the study period; their total was 150 patients.

2.9. Data management

Data was exported to SPSS version 25.0 for analysis.

2.10. Data analysis

Descriptive analysis was performed for all study variables with mean and standard deviation. Bi-variable analysis was used to determine the associations between the main outcome variable and the other relevant risk factors with Chi square test (for categorical variables) and P-value of 0.05 or less was considered statistically significant.

2.11. Ethical considerations

It was obtained from the concerned bodies.

3. Results

The study population composed of 150 patients who underwent laparoscopic cholecystectomy at Wad Madani Teaching Hospital; Gezira State; Sudan; during the study period (from November 2022 to November 2023). The age of the participants ranged from 17 to 85 years, with a mean age of 47.57 (SD ±15.14). The majority of the patients were female (93.3%, n=140), with only 6.7% (n=10) being male. Gallstones were present in 99.3% (n=149) of the patients, while only 0.7% (n=1) did not have gallstones detected by ultrasound.

Table 1 Presence and subtypes of Rouviere's sulcus (RS), Rouviere's Sulcus: Frequency and Types among Patients presented to Wad Madani Teaching Hospital for Laparoscopic Cholecystectomy; Gezira State; Sudan; (n = 150)

Characteristic		**No. & %**
RS Intraoperative	Present	139 (92.7%)
	Absent	11 (7.3%)
RS Subtype	Open	81 (54.0%)
	Close	41 (27.3%)
	Scar	17 (11.3%)

The frequency of the Rouviere's sulcus was high among the participants. It was identified intraoperatively among 139 of them with a percentage of 92.7% of the cases, while it was absent among 11 of them with a percentage of 7.3%. The different subtypes of sulcus observed were as follow: Open sulcus, it was the most occurring type of the sulcus, and was observed among 81 of the participants indicated a percentage of 54.0%; Close sulcus, it come in the second step to the Open sulcus, was identified among 41 of the participants, showing a percentage of 27.3%; and the last one was the Scar sulcus, it was the least occurring type of the sulcus which was observed among 17 of the participants with a percentage of 11.3%. (Table 1)

Table 2 Relation of postoperative operative outcomes to RS, Rouviere's Sulcus: Frequency and Types among Patients presented to Wad Madani Teaching Hospital for Laparoscopic Cholecystectomy; Gezira State; Sudan; (n = 150)

Postoperative Outcome	RS Absent (n = 11)	RS Present (n = 139)	p-value
Uneventful	10 (90.9%)	133 (95.7%)	0.470
Complications	1 (9.1%)	6 (4.3%)	

Regarding postoperative operative outcomes: The rate of uneventful postoperative outcomes was found to be high among the participants, where 143 of them experienced peaceful postoperative outcomes, with a percentage 95.3%; while, there was a low incidence of postoperative complications among them, where only 7 patients developed postoperative complications, yielded a percentage of 4.7%. There was no statistical association between the presence of RS and postoperative complications among the study population (P-value = 0.470). (Table 2)

Table 3 Gender vs the presence of RS, Rouviere's Sulcus: Frequency and Types among Patients presented to Wad Madani Teaching Hospital for Laparoscopic Cholecystectomy; Gezira State; Sudan; (n = 150)

Gender	RS Absent (n = 11)	RS Present (n = 139)	p-value
Male	2 (20%)	8 (80%)	0.112
Female	9 (6.4%)	131 (93.6%)	

The percentage of the occurrence of the Rouviere's sulcus among male participants was 80%; while among female participants was 93.6%. So, the frequency of the presence of the Rouviere's sulcus was high among the female participants compared to the male participants. In spite of that there was no significant statistical association between the gender and the presence of the Rouviere's sulcus among our study population. (P-value 0.112). (Table 3)

Table 4 Gender vs the subtype of RS, Rouviere's Sulcus: Frequency and Types among Patients presented to Wad Madani Teaching Hospital for Laparoscopic Cholecystectomy; Gezira State; Sudan; (n = 150)

Gender	RS subtype (n = 139)			p-value
	Open	Close	Scar	
Male	4 (40%)	2 (20%)	2 (20%)	0.301
Female	77 (55%)	39 (27.9%)	15 (10.7%)	

The frequency of the occurrence of the different types of the Rouviere's sulcus - open sulcus, close sulcus, and scar sulcus - among the male participants was 40%, 20%, and 20%, respectively. While among the female participants, the frequency of the occurrence of the different types of the Rouviere's sulcus - open sulcus, close sulcus, and scar sulcus – was 55%, 27%, and 10.7%, respectively. There was no significant statistical association between the gender and the sulcus type among the study population (P-value 0.301). (Table 4)

4. Discussion

Laparoscopic cholecystectomy is considered as gold standard treatment for gallstones disease, it found to be related to high incidence of complications involved bile duct injury (0.6%), vascular injury (0.14%) and bowel injury (0.25%) [1, 6-11]. Accurate identification of the hepatobiliary anatomy is mandatory for safe laparoscopic cholecystectomy as most of the bile duct injuries are associated with the misidentification of this anatomy. As response for these complications surgeons developed many strategies to avoid it during the laparoscopic cholecystectomy. These strategies were created using careful dissection techniques, anatomical knowledge, and surgical attentiveness, one of these strategies is Rouviere's sulcus (RS) [1, 2, 5, 6, 8, 9, 11, 15, 18, 19, 21, 23-26]. This study involved 150 participants including 140 (93.3%) females and 10 (6.7%) males, this was similar to international study [30]; as female gender associated with more risk factors for gallstone disease. Our study showed the presentation of Rouviere's sulcus (RS) in 139 (92.7%) of the participants which is similar to what is report worldwide [4, 5, 6]. The types of Rouviere's sulcus (RS) which revealed by our study were: open, close, scar; this is typical to what is mentioned globally [1, 16, 17, 21, 27]. Our study showed no significant statistical association between the presence of the Rouviere's sulcus and the postoperative complications

(P-value = 0.470), unlike many international reports [7, 8] that revealed the presence of the Rouviere's sulcus has significant role in providing safe dissection during laparoscopic cholecystectomy and therefore decrease the risk of complications. We identified, in this study, absence of significant statistical association between gender and both: the presence and the types of the Rouviere's sulcus. Actually, we did not come across international studies discussing this relation. The main limitation of this study is that the sampling method is a purposive method, so, the participants were not well representative of the general population.

5. Conclusion

The overall frequency of the Rouviere's sulcus, identified intraoperatively, was high among the participants. Regarding the gender, the presence of the Rouviere's sulcus was found to be high among the female participants compared to the male participants. Apart from the scar type of the Rouviere's sulcus, the frequency of the types was high among the female participants compared to the male participants. There was no significant statistical association between the presence of the Rouviere's sulcus and the postoperative complications. Absence of significant statistical association between gender and both: the presence and the types of the Rouviere's sulcus, was identified.

Recommendations:

Further study in this field was highly recommended.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of ethical approval

Ethical approval was obtained from the Research Ethical Committee (REC) of the Sudan Medical Specialization Board.

Statement of informed consent

Informed consent was obtained from the concerned bodies.

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