ORIGINAL RESEARCH

The Anatomical Variations of Rouviere's Sulcus Observed during Laparoscopic Cholecystectomy in Egyptian Patients

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Abstract

Background: Laparoscopic cholecystectomy (LC) became one of the most common operations worldwide. Bile duct injury usually occurs due to a failure to recognize the critical structures in Calot's triangle. A proper knowledge about biliary structures, its anatomicl variations, and identification of various anatomical landmarks is essential to make LC easy and safe. Although Rouviere's sulcus (RS) was initially described by Henri Rouviere in 1924, it is not widely known and not often incorporated in LC. In cirrhotic patients, the incidence of gallstones is higher than in general population.

Aim: To determine the frequency and types of RS as seen during LC and to assess the benefits of identifying *Rouvier's salcus* as an anatomical landmark in avoidance of bile ducts injury during LC in Egyptian patients.

Materials and methods: A prospective study was conducted on 290 patients with gallbladder diseases, 250 non-cirrhotic (group A) and 40 cirrhotic patients (group B) who scheduled for LC at National Hepatology and Tropical Medicine Research Institute (NHTMRI), Cairo, Egypt in a period of 30 months.

Results: Among group A *RS* was clearly identified as a deep sulcus in 190 patients (76%), in 40 patients (16%), *RS* was identified as a scar, while it was absent in the remaining 20 patients (8%). Among group B, *RS* was clearly identified as a deep sulcus in 9 patients (22.5%), in 11 patients (27.5%), *RS* was identified as a scar, while it was absent in the remaining 20 patients (50%).

Conclusion: Identification of RS provides an easy landmark for starting dissection of Calot's triangle for safe LC as it facilitates the identification of the biliary and vascular structures and minimizes iatrogenic biliary injuries. Identification of RS may not be easy in liver cirrhosis and need careful dissection of vascular and biliary structures.

Keywords: Laparoscopic cholecystectomy, Liver cirrhosis, Rouviere's sulcus.

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Introduction

In 1420, cholelithiasis was first described by Antonio Benivenius, and since 1882, cholecystectomy is performed initially by a German surgeon named Johann August, the first surgeon who performed open cholecystectomy. In 1987, Phillip Mourett was the first surgeon performing LC. Cholecystectomy becomes a commonly performed surgical operations worldwide, whereas more than 750,000 cholecystectomies are performed yearly in the USA alone. With the era of LC, there was an increasingly number of bile duct injuries with the incidence of 0.3–0.5% of LCs, which is considered a serious complication of this procedure. So, there is an increasing need for identification of various anatomical landmarks which makes LC safer. A proper knowledge about anatomical variations within the Calot's triangle is the milestone to perform safe cholecystectomy, together with meticulous identification of cystic biliary and vascular structures is considered the gold standard to minimize the incidence of biliary tree injuries.[1]

As LC now represents the vast majority of cholecystectomies all over the world due to better cosmetic outcome, less hospital stays, and minimal rest from work compared to open cholecystectomies. There is still incidence of complications of LCs including bile duct injuries, bile leakage, and massive bleeding.[2] The strategy for safe LC without surgical complications in addition to the proper knowledge about biliary structures and biliary congenital anomalies, focused on identification of various anatomical landmarks that makes LCs easy and safe.[3]

In 1924, Henry Rouviere identified an important fissure in the liver between the right lobe and the caudate process which was easily seen during the posterior dissection for LC in the majority of patients. RS, which is a cleft in the liver, could be identified in approximately 90% of patients and clearly seen by grasping the gall bladder and retracting it medially. The length and depth of RS vary in different individuals, and with the increasing number of LCs. This salcus got more importance as a landmark for safe cholecystectomy because of its relation to the right portal pedicle which made it a gold extrabiliary landmark for safe cholecystectomy.[4–6]

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In cirrhotic patients, the incidence of gallstones is higher than in general population. In cirrhotic patients, symptomatic gallstones are associated with higher morbidity compared to the rest of the population. The risk for developing complicated gallstone disease must be strictly weighed against the risk of surgery.[7,8]

Aim of the Work

The aim of this study is to determine the frequency and types of RS as seen during LC and to assess the benefits of identifying RS as an anatomical landmark in avoidance of bile ducts injury during LC in Egyptian patients.

Materials and Methods

This is a prospective study which was conducted on 290 patients with gallbladder diseases, 250 non-cirrhotic patients (group A) and 40 cirrhotic patients (group B) who scheduled for LC at NHTMRI, Cairo, Egypt in 30 months after approval from ethical committee and informing the patients and getting written consent.

All patients were investigated using preoperative ultrasound, laboratory investigations including liver functions, complete blood count (CBC), blood sugar, renal functions, coagulation profilem, electrocardiogram (ECG), and echocardiography when indicated.

In this study, we used the (EPIQ 7 Machine – Philips ultrasound and Doppler) for the preoperative ultrasound assessment. Cirrhosis was confirmed in group B by preoperative ultrasound. Ultrasound findings of cirrhotic liver is the characteristic nodular surface, coarse heterogeneous echo-pattern, hypertrophy of left lobe, increase width of the caudate lobe, and reduction of the diameter of the medial aspect of the left hepatic lobe (segment IV), some cases showing attenuation of calibre of hepatic veins with monophasic flow (portalization of hepatic venous flow). Postoperative ultrasound was performed to confirm patency of biliary system and clearance of operative bed , also for the early detection of any postoperative complication like operative bed collection, biliary leak infection, and abscess or hematomas formation.[9]

Routine anesthetic check-up was performed for all the patients including ECG and chest X-ray.

All patients were subjected to LC by the same surgeons, using the four-port technique with introduction of the first 10-mm port blindly at the umbilicus, after carbon dioxide insufflation, using it as a camera, the second 10-mm port was introduced under vision at the epigastrium just lateral and to the right of the falciform ligament, the remaining two ports were introduced under vision of the camera, both were 5-mm, one below the costal margin in the mid clavicular line, the other was under the costal margin in the anterior axillary line for retracting the fundus.

After the exploration of the whole abdomen, the gall bladder is identified and grasped from its fundus cephalic toward the diaphragm, and the Hartman pouch is grasped and retracted inferiorly and toward the right to explore the Calot's triangle for starting dissection.

Starting from a fixed point to the right of the Calot's triangle, RS is checked for its presence and observed whether the sulcus is clearly seen, hardly seen, or not identified as shown in Figure 1. The type of the sulcus, if present, is examined for, is it of open type (Fig. 2), closed type (Fig. 3), or scar type, and if it is of the open type, then the length, width, and depth of the sulcus is assessed, and the relation between the sulcus and the right hepatic pedicle is checked for.

Fig. 1: Absent RS

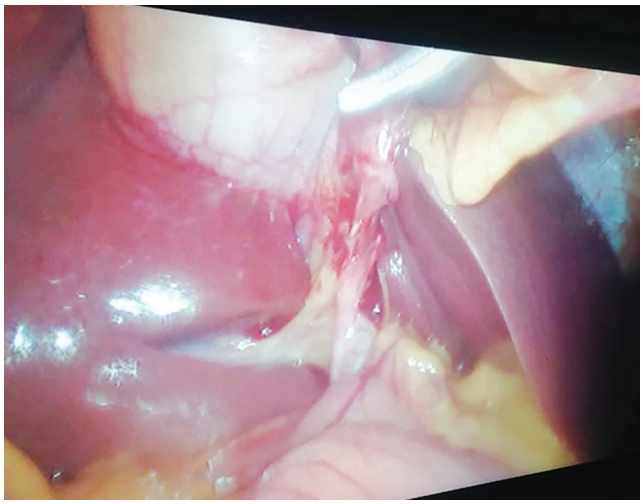

Fig. 2: RS open type

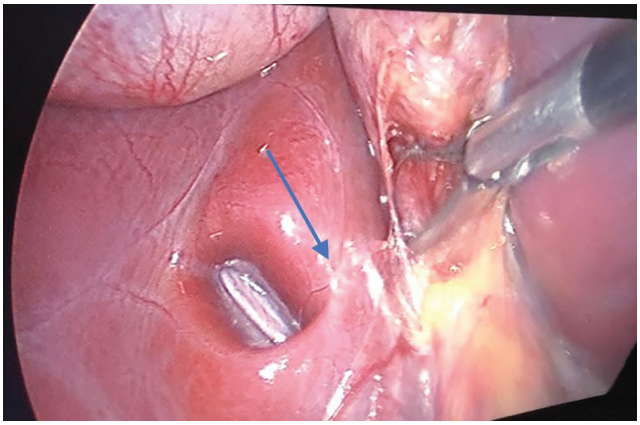

Fig. 3: RS closed type

After a good exposure of the Calot's triangle starting carful dissection of the structures within the pedicle of the gall bladder, in a plan anterior to the RS after proper de-peritonealization using bipolar electrocautery with maximal attempt to achieve proper hemostasis.

After identifying the cystic duct and cystic artery, both of them are clipped proximally with two clips, and one distally and both of them were cut, then dissection of the gall bladder from its bed is

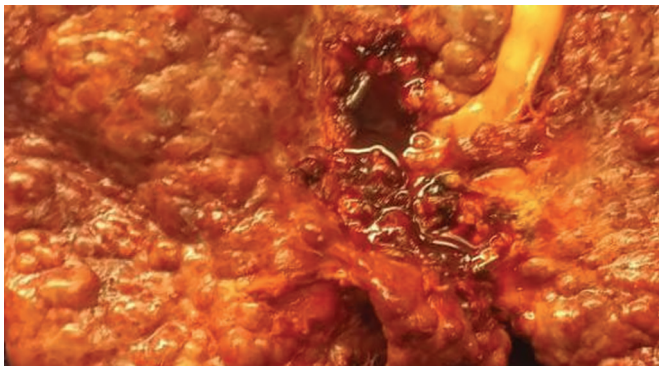

Fig. 4: Absent RS in cirrhotic liver

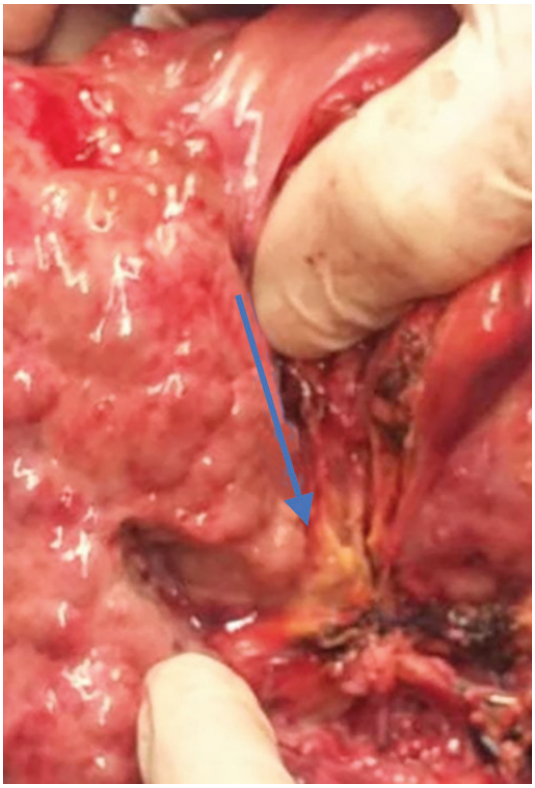

Fig. 5: RS open type. *Note:* Figures 4 and 5 were taken from recipient during liver transplantation for demonstration

done using electrocautery, and drain is put in the Morisson pouch, and the four wounds were closed.

Figure 4 shows absent sulcus and Figure 5 shows closed sulcus in cirrhotic patients obtained during liver transplantation just for demonstration.

Results

We divided the patients into two groups: group A: Non-cirrhotic (250 patients) and group B: cirrhotic (40 patients).

In group A, a total of 250 surgically fit patients subjected to elective LC in 30 months, 185 (74%) were females and 65 (26%) were males with a mean age of 45.2 ± 6.1 years, (range, 22–55 years). In group B, 40 surgically fit patients, child A 29 (72.5%) were females and 11 (27.5%) were males with a mean age 53.7 ± 7.1 years (range, 38–61 years).

Table 1: Data collected about the RS in group A

RS	*Number of patients*	*Percentage*
(A) Sulcus	190	76
Open	136	
Closed	54	
(B) Scar	40	16
(C) Absent	20	8

There were 220 patients (88%) complaining from chronic calcular cholecystitis, 10 patients (4%) were suffering from obstructive jaundice and performed endoscopic retrograde colangiopancreatography (ERCP) 1–3 months before cholecystectomy, and the remaining 20 patients (8%) complaining from acute cholecystitis.

Among group A (250 patients), RS was clearly identified as a deep sulcus in 190 patients (76%) (136 with open sulcus and 54 with closed sulcus), in 40 patients (16%), RS was identified as a scar, while it was absent in the remaining 20 patients (8%). Among group B (40 patients), RS was clearly identified as a deep sulcus in 9 patients (22.5%) (3 with open sulcus and 6 with closed sulcus), in 11 patients (27.5%) RS was identified as a scar, while it was absent in the remaining 20 patients (50%).

Among the 190 patients with clearly identified RS, 130 patients (68.4%) underwent an easy and straight forward LC, while in the 60 patients (31.6%), 10 of them (4%) had accessory artery arising from the gall bladder bed, 40 of them (16%) took more time for delineation of the biliary anatomy due to either very short cystic duct or sessile gall bladder, the remaining 10 patients (4%) five of them were converted to open cholecystectomy due to failure to identify the bile ducts safely due to frozen Calot's triangle, and the other 5 had empyema of the gall bladder and necessitate aspiration prior to clamping of the gall bladder.

Among the 250 patients' cholecystectomies, no injury to the bile ducts was suspected or reported in all patients, 10 patients (4%) developed hematoma at the site of the gall bladder bed which was small and resolved spontaneously with no intervention, while 5 patients (2%) developed bile leak through the drain by the second day which continued for 1 week and gradually stopped with no residual abdominal collection. Also, 130 patients (52%) were discharged from the hospital in the same day of the operation, 100 patients (40%) were discharged on the next day, 15 patients (6%) stayed in hospital for 2 days, while the remaining patient (2%) left the hospital after one week. No mortality was recorded during this study. The data collected about the RS in group A are described in Table 1 and Figure 6.

With regard to group B (cirrhotic patients), total of 40 child A patients subjected to LC in 30 months.

Among the 40 patients, RS was absent in 20 patients (50%), while in 9 patients (22.5%), RS was identified as a scar, and it was identified as a sulcus in the remaining 11 patients (27.5%).

Twelve patients underwent a relatively easy and straight forward LC (8 patients with identified sulcus and 4 of the 11 patients with the sulcus identified as a scar), while in 28 patients (one with sulcus, 7 with just scar and 20 with absent RS) the operations were relatively more time consuming and more technically difficult. Two cases of those 28 patients were aborted without cholecystectomy due to advanced cirrhosis than expected, so the expected hazard is

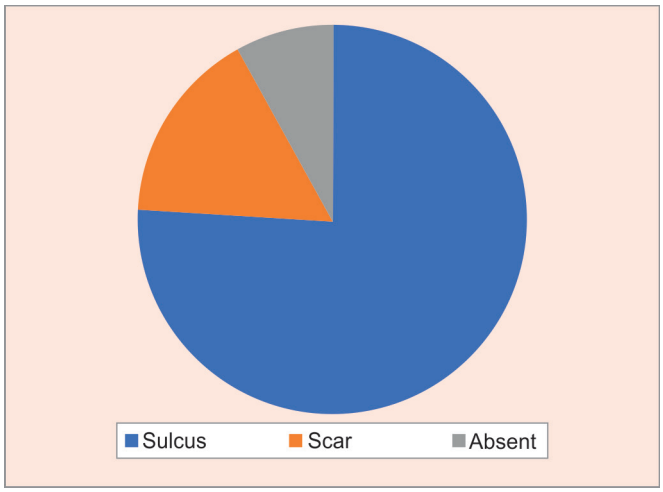

Figure 6: RS in group A (non-cirrhotic)

Table 2: Data collected about the RS in group B

RS	*Number of patients*	*Percentage*
(A) Sulcus	9	22.5
Open	3	
Closed	6	
(B) Scar	11	27.5
(C) Absent	20	50

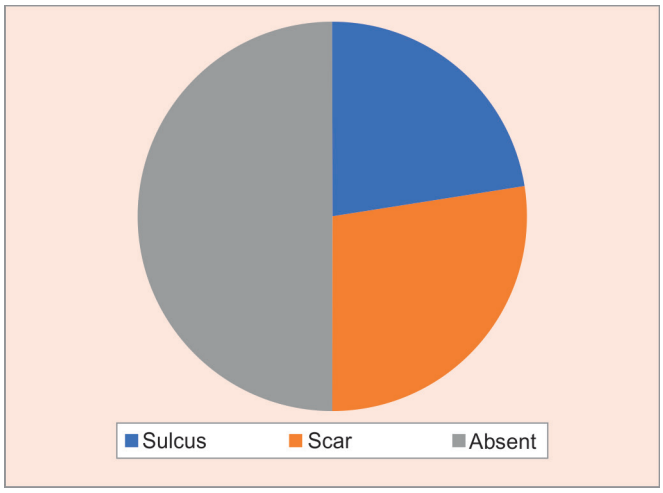

Figure 7: RS in group B (cirrhotic)

more than the benefit and two patients were converted to open cholecystectomy due to extremely difficult anatomy.

Of these 28 patients, 3 cases developed gallbladder bed bleeding and was controlled by compression and surgical foam, 3 cases developed postoperative ascites with liver impairment and 1 case developed postoperative wound infection. No bile duct injury recorded in this group. Thirty patients (75%) were discharged from the hospital in the next day of operation, 10 patients (25%) stayed in hospital for more than 2 days to 1 week. No mortality was recorded during this study. The data collected about the RS in group B are described in Table 2 and Figure 7.

Discussion

With the increasing number of LCs all over the world, there is a risk of biliary tract injuries (0.4–1.5% of cases) inspite of marked improvement in the techniques and devices of laparoscopies.[10]

Anatomical variation of the biliary system, together with the lack of proper identification of the anomalies of the vascular and biliary structures, are the main causes of iatrogenic injuries of the biliary tree.[11]

Rouviere's sulcus, also known as incisura hepatica dextra or Gans incisura, was first described by Henri Rouviere in 1924, as a cleft 2–3 cm. Just anterior to segment I and running to the right of the liver hilum and is usually containing the right portal triad, and it marks the plane of common bile duct accurately. Although not all the classic anatomical literatures include data on RS, its importance is due to its location in a line where the cystic duct and cystic artery lay anterosuperior to the sulcus, and the common bile duct lays below the level of RS, so the minimal complications occur if the surgeon starts dissection during cholecystectomy in a plane anterior to it.[4]

Gans described RS in 80% of the livers, Reynaud et al. reported the incisura dextra of Gans in 73% of cases, Hugh et al. found it in 90% of livers.[12–14]

To the best of our knowledge, no research found discussing RS in patients with liver cirrhosis. In this study, we found RS in 92% of the patients having no cirrhosis while it was found in 50% of the patients having liver cirrhosis.

Identification of RS provides an easy landmark for starting dissection of Calot's triangle for safe LC. In this study, among the 250 patients RS was clearly identified in 92% of patients; as a deep sulcus in 76%, as a scar in 16%, while it was absent in the remaining 8% of patients. These results are comparable to results of Abhijeet Kumar study in 2020 as they found the sulcus present in 90.4%; as a sulcus in (77.1%) and scar in (22.9%) but differ from Stuart Lockhart in 2018 how mentioned that RS, occurs in over 80% and absent in 20% of normal livers during laparoscopic cholcystectomy.[15,16] This study also differs from the Lazarus, et al. study in 2018 as their study included the gross anatomical examination of 75 formalin-fixed, adult livers and not on living patients the sulcus was present in 82.67% and the study of Rohin Garg 2019, where the RS was present in 78.89% out of the 90 livers dissected cases.[17,18]

The aforementioned studies described the shape of sulcus (if present) as scar, slit, and deep sulcus. The deep type of sulcus may have a considerable length, breadth, and depth, and is divided into open and closed type according to the medial end of it whether open or closed. The scar type sulcus takes the shape of superficial white line which possibly represents the fused sulcus, while the slit type is shallow in depth and narrow in width. However, in this study, we presented the results as sulcus (open and closed), scar, or absent.

Although the RS varies in shape, depth, and width, but it constantly provides an anatomical landmark to the line of common bile duct, where Hugh et al. reported that fewer common bile duct injuries had been occurred in LC when the surgeons started dissection of the Calot's triangle in a plane ventral to the sulcus. Identification of RS may not be easy in certain conditions with unclear anatomy like liver cirrhosis, fatty liver, and contracted or intra hepatic gall bladder are present. So, the distorted anatomy may obscure the RS or confuse the anatomy of the porta hepatis with

misleading of the vascular and biliary structures. With obscured RS or with frozen Calot triangle, meticulous dissection of vascular and biliary structures, adequate exposure of the cystic duct and artery, remain the cornerstone for safe LC.[19–21]

In this study, RS was visualized in 92% of cases with healthy livers, while it was visualized in only 50% of cases with cirrhotic livers during LC. We believe that the current study is one of the first works discussing the RS in cirrhotic livers and we did not find studies discussing RS in cirrhotic livers to compare to our study.

Conclusion

Identification of RS provides an easy landmark for starting dissection of Calot's triangle for safe LC as it facilitates the identification of the biliary and vascular structures and minimizes iatrogenic biliary injuries. Identification of RS may not be easy in liver cirrhosis and need careful dissection of vascular and biliary structures.

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