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To Study The Role Of Various Anatomical Landmarks For Safe Laparoscopic Cholecystectomy With Particular Reference To Rouviere's Sulcus

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Abstract:*This study discusses anatomical landmarks that are of relevance to the performance of a safe laparoscopic cholecystectomy and to determine the role of the Rouviere Sulcus, its description, its location and to evaluate the surgical relevance of the obtained data for safe Laparoscopic Cholecystectomy.The study was conducted from October 2017 to September 2019 in Department of General Surgery, Subharti Medical College, Meerut where 236 patients were evaluated who underwent classical four port Laparoscopic Cholecystectomy and careful note was made of Rouviere sulcus- presence, type, relations. Other anatomical landmarks: Gall Bladder, Hepato-Cystic triangle, Cystic artery, Cystic Duct- their anatomical variations and distortions were studied with aim to make operative surgeon aware about them and guide them during laparoscopic cholecystectomy.*

Keywords*: Rouviere's sulcus, Safe laparoscopic cholecystectomy, Anatomical landmarks, Cholelithiasis*

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I. Introduction:

Laparoscopic Cholecystectomy is accepted as standard procedure for gallstone disease. It is associated with an overall complication rate of approximately ten percent with a higher risk of biliary injury (0.1%-1.5%) [1-3] when compared to the open approach (0.1%-0.2%)[1-4]. This complication, if sustained, largely offsets the benefit of the minimally invasive approach. Recent data suggest a declining trend in the bile duct injury (BDI) rate (0.32%-0.52%) without any significant change in the morbidity or mortality after LC [4]. However, it is important to recognize the fact that most of these injuries are preventable, especially if a structured safe technical protocol is followed. Factors predisposing to Bile Duct Injury/Vascular-Biliary Injury are related to anatomy, disease related pathology, structural misidentification and improper techniques [5,13]. The most common mechanism of such injuries involves the misidentification of the common bile duct (CBD) or common hepatic duct (CHD) as the cystic duct or the misidentification of the hepatic artery as the cystic artery [9].

II. Material and Methods:

This was a prospective descriptive study of 236 patients who presented with symptomatic gallstone disease and underwent laparoscopic cholecystectomy. The study conducted from October 2017 till September 2019 at Subharti Medical College, Meerut. All patients had a preoperative abdominal ultrasound, liver function tests, and complete blood count. The operation was done under general anaesthesia with classical 4 ports.Informed consent was obtained from all patients for being included in the study. Ethical approval was obtained from the institutional ethical and scientific committee before commencing this study.

During the procedure careful note was made of:

a. Rouviere's Sulcus

i. Presence

ii. Type of sulcus

Rouviere's sulcus was noted in the operative note and classified according to following [14]:

TypeI: Open type was defined as a cleft in which the right hepatic pedicle was visualized and the sulcus was opened throughout its length.

Type II: if the sulcus was open only at its lateral end.

Type III If the sulcus was open only at its medial end.

Type IV: Fused type was defined as one in which the pedicle was not visualized.

iii. Relation with CBD

b. Gall Bladder
i. Visualised >3cm out of liver margin
ii. Adhesions
iii. Hartmann's pouch (normal/dilated)
iv. Empyema/ Mucocele

c. Hepato-cystic triangle
i. Fibrosis
ii. Lymph node of Lund relation with CHD

d. Cystic artery and Right hepatic artery
i. Presence
ii. Position
iii. Anomalies of vascular system

e. Cystic Duct
i. Length
ii. Presence of accessory duct(s)
iii. Anomalies of biliary system

f. Intra Operative Complications
i. Bleeding from tissue adjacent to GB
ii. Bleeding from cystic artery
iii. Iatrogenic perforations of GB
iv. Injury to the CBD
v. Spilled gall stones
vi. Lesions of omentum
vii. Intra op bleeding

g. Other factors:
i. Reason for conversion to open cholecystectomy.
ii. Any other significant findings.

The operative timing was noted from the first port site incision till the last port closure. The scoring system devised by Randhawa et al. [15] to predict the degree of difficulty in performing laparoscopic cholecystectomy was used and the cases were grouped as easy, difficult and very difficult.
Group Description:
Easy: Time taken <60 min, No bile spillage, No injury to duct, artery
Difficult: Time taken 60 to 120 min, Bile/stone spillage, Injury to duct, No conversion
Very difficult: Time taken >120 min, Conversion

III. Results and Discussion:

Hartmann's Pouch and its significance in safe laparoscopic Cholecystectomy:

The 'Hartmann's pouch' an out pouching of the wall in the region of the neck of gall bladder. This pouch is variable in size and can be grossly dilated in size. In this study, dilated Hartmann's Pouch was visualised in 35(15%) patients, a dilated Hartmann's pouch may obscure the cystic duct and the Calot's triangle. This may be result of plain enlargement or due to adherence to the cystic duct or bile duct. Thus a small cystic duct can get completely hidden and traction on the gallbladder can lead to the bile duct looking like the cystic duct. This can create major difficulty during a cholecystectomy.

Lymph node of Lund and its significance in safe laparoscopic Cholecystectomy:

Cystic LN is classically identified as a single node overlying the cystic artery and lateral to the bile duct. It thus represents another important landmark during LC. In this study Cystic LN of Lund was visualised in 232 (98%) patients and in all the visualised cases it was present lateral to Right Hepatic Duct. Hence it can be safely concluded that Cystic Lymph Node of Lund is an important extra biliary landmark that must be identified during laparoscopic cholecystectomy and all the dissection should be kept lateral to lymph node in order to carry out Laparoscopic Cholecystectomy safely. Surgeons can use given relation as a landmark for the identification and clipping of the cystic artery.

Cystic Artery, Right Hepatic Artery and their significance in safe laparoscopic Cholecystectomy:

The cystic artery is a branch of the right hepatic artery (RHA) and is usually given off in the Calot's triangle. It has a variable length and enters the gallbladder in the neck or body area. The course and length of the cystic artery in the Calot's triangle is variable. Although classically the artery traverses the triangle almost in its center, it can occasionally be very close or even lower than the cystic duct.

It usually gives off an anterior or superficial branch and a posterior or deep branch. This branching usually takes place near the gallbladder. When the point of dissection is very close to the gallbladder as in a LC or the branching is proximal, one may have to separately ligate the two branches. Also if the presence of a posterior branch is not appreciated it can cause troublesome bleeding during posterior dissection.

In this study incidence of involving 236 patients, in 17 (7.2%) patients the Cystic Artery was present outside the Calot's Triangle, double Cystic Arteries was seen in 15 (6.3%) patients and early branching of Cystic Artery was present in 4 (1.6%) patients.

The RHA normally courses behind the bile duct and joins the right pedicle high up in the Calot's triangle. It may come very close to the gallbladder and the cystic duct in the form of the 'caterpillar' or 'Moynihan's' hump. In this study the Moynihan's hump was seen in 4 (1.6%) patients. In such patients, the cystic artery in turn was very short. In this situation the RHA is either liable to be mistakenly identified as the cystic artery or torn in attempts to ligate the cystic artery. The ensuing bleeding in turn predisposes to biliary injury. Keeping the dissection of the artery close to the gallbladder on the right side of the cystic lymph node (a fixed landmark) may prevent injury to the right hepatic artery.

In total, 38(16.1%) vascular anatomical variations were present, knowledge and awareness of these anatomical variations in cystic artery and RHA is must among surgeons to appreciate them intraoperatively and carry out safe laparoscopic cholecystectomy.

Cystic Duct and its significance in safe laparoscopic Cholecystectomy:

The cystic duct joins the gallbladder to the bile duct and is one of the important structures needing proper identification and division during a standard cholecystectomy. The cystic duct may run a straight or a fairly convoluted course. Its length is variable and usually ranges from 2 to 4 cm. Short cystic ducts are less than 2 cm. Hence there may be very little space to put clips or ligatures. The cystic duct is usually 2–3 mm wide. It can dilate in the presence of pathology (stones or passed stones). The normal bile duct is also around 5 mm and hence can look like a mildly dilated cystic duct. In general a cystic duct larger than 5 mm (or the need to use a very large clip to completely occlude the duct) should arouse a suspicion of mistaken identity with the bile duct before it is clipped or ligated. Cystic duct entire course and its junction with the CBD do not need to be delineated during LC as it is not required and it will put the bile duct at risk of injury specially in case of parallel insertion where the part of the cystic duct may be adherent to the CHD due to inflammation. A congenitally absent cystic duct is a very rare condition. If the cystic duct is not apparent during cholecystectomy then either it is short or it may be effaced by the stone or the Mirizzi syndrome is present. The surgeon should be careful while dissecting in the HC triangle in such situation and may need to resort to one of the bail-out techniques as discussed later. Similarly, if two cystic ducts are visible, surgeon should be very careful in labelling this as double cystic ducts and dividing these structures.

In this study 2(0.8%) patients had short cystic duct (<2cm) while only 1(0.4%) patient had accessory cystic duct. In total, only 3(1.2%) cystic duct anatomical variations were seen in 236 patients.

Hence cystic duct variations (1.2%) are less common as compared to vascular variations (16.1%). However surgeons must not ignore its occurrence and must be vigilant during Calot's dissection as bile duct injury can cause severe morbidity and occasionally mortality.

Rouviere's Sulcus and its types and role in Safe Laparoscopic Cholecystectomy

Rouviere's sulcus is also called as the incisura hepatica septa, or Gans incisura. It was initially described in 1924 by Henri Rouviere, a French anatomist [15]. He used it as a reference point to guide the commencement of safe liver dissection and named it "le sillon du processuscaude" [17]. It has been described in 80% of livers [18]. It is a 2 to 3 cm fissure on the liver between the right lobe and the caudate process, usually containing the right portal triad or its branches. The sulcus indicates the plane of the common bile duct accurately. The sulcus corresponds to the level of the porta hepatis where the right pedicle enters the liver. The cystic duct and the cystic artery lie antero-superior to the sulcus, and the common bile duct lies below the level of the Rouviere's Sulcus [19]. In our study in 100% cases of visualised gall bladder CBD was present below the sulcus.

Being an extra-biliary reference point, it does not get affected by distortion due to pathology [15].

Four types have been identified: I- Open right hepatic pedicle visualized and sulcus open throughout its length; II- Sulcus open only at its lateral end; III- Sulcus was open at its medial end; IV- Fused: Pedicle was not visualized [20].

Rouviere's Sulcus was identified in 169 patients (71.6%) in our study. Reynaud et al.[20] have reported Rouviere's Sulcus in 73% cases, Hugh et al. [21] in 78% patients and Zubair et al. [17] in 68% of their cases.

Hugh [21] showed minimal common bile duct injury during laparoscopic cholecystectomy by beginning the dissection ventral to the Rouviere's Sulcus.

Thapa et al. [19] have mentioned Type I as the commonest (54%) in their study. Our study also had the Type I Rouviere's Sulcus as the commonest type (51.3%). Peti and Moser [15] have also described a case where identification of the Sulcus helped prevent a common bile duct injury. Shinde and Pandit[22] have described a novel approach for dealing with a frozen Calot's triangle, by consistent identification of a series of anatomical landmarks including Rouviere's Sulcus, creation of a retro-gallbladder tunnel, and encircling of the gallbladder with gauze.

In our study, the relationship of identification of Rouviere's Sulcus with ease of performing laparoscopic cholecystectomy was statistically significant.

Rouviere's sulcus has several advantages over Calot's triangle for safe dissection during difficult laparoscopic cholecystectomy. First, Calot's triangle in an operative textbook, and Calot's triangle during the operation itself often bears little resemblance. Dissection is needed to expose the vital structures that form the boundaries of the triangle. Safe dissection might be difficult due to the consequences of acute or recurrent cholecystitis, with inflammation, edema, and fibrosis of the structures leading to obscuration of the anatomical landmarks. Calot's triangle in this setting is often solid and cannot be expanded, and it can be hard to achieve a critical view of safety. This is in contrast to Rouviere's sulcus, which remains relatively unaffected by inflammation and fibrosis. Rouviere's sulcus might be used as a confirmatory tool and is particularly useful when identification of structures within Calot's triangle remains difficult. The cystic duct and artery lie anterosuperior to the sulcus, thus acting as a safety check before the ligation of any structures.

Understanding and Execution of Correct Technique

- Proper retraction of fundus towards right shoulder of the patient and right inferolateral retraction of neck allows adequate exposure of hepatocystic triangle.
- Identification of fixed landmarks (Rouviere's sulcus, Lymph node of lund, Bile duct, Right hepatic artery, enteric structures) to mentally orient for existing anatomy.
- Re-identifications of landmarks in case of difficulty/doubt, to reorient before proceeding for dissection.
- Achieving the Critical View of Safety for conclusive identification of cystic duct and cystic artery.
- Stop before division of cystic duct and artery to reconfirm that CVS has actually been achieved.

Strategies to handle Difficult Situations

- Patients having fibrosis and/or adhesions and/or inability to achieve CVS should be considered as difficult cases.
- Identification of fixed landmarks (Rouviere's sulcus, Lymph node of lund, Bile duct, Right hepatic artery, enteric structures) and using them as guide for dissection can remove adhesions in most of cases and delineate anatomy to carry out further surgery safely.
- Severe adhesions, severe acute inflammation, Mirizzi syndrome, or chronic inflammation with fibrosis or scarring may lead to failure of timely progression of the dissection, anatomic disorientation, and difficulty in visualization of operative field.

Thus the operating surgeon should be able to identify or pre-empt the difficult situation that might increase the risk of biliary/vascular injury and opt for bailout techniques.

Bailout techniques/strategies

There are five bailout strategies for a difficult gallbladder [23,24,25]:

- Abort the procedure altogether
- Convert to an open procedure
- Tube cholecystostomy
- Subtotal cholecystectomy (STC, open/laparoscopic); and
- Fundus first cholecystectomy

In this study severe fibrosis was encountered in 11(4.6%) cases out of which 10 were converted to open cholecystectomy and one was converted to subtotal laparoscopic cholecystectomy.

Hence, in today's world conversion to open is no more considered to be a complication but a way to carry out Cholecystectomy safely. A surgeon must have low threshold for conversion of procedure to open surgery.

IV. Conclusion

- Most common patients presenting with symptomatic gallstones are middle aged females.
- Operating surgeon must be aware of various anatomical landmarks and anatomical variations to guide them safely through LC and prevent injury to vasculo-biliary structures.
- Dilated hartmann's pouch may obscure/ get adhered to cystic artery or duct and can be a cause of injury during LC.
- Cystic Lymph Node of Lund is fairly consistent extra-biliary landmark present lateral to Right Hepatic Duct, dissection should be kept lateral to it.
- Vascular variations are commonly encountered (16.1%) during LC and lack of awareness about them may lead to vasculo-biliary injury.
- Bile duct variations are less common (1.2%) but can cause severe morbidity and rarely mortality if not tackled meticulously.
- Rouviere's Sulcus is a fixed extrabiliary landmark present in 71.6% of patients, cystic duct and the cystic artery lie antero-superior to the sulcus, and the common bile duct lies below the level of the Rouviere's Sulcus.
- Being an extra-biliary reference point, it does not get affected by distortion due to pathology. Dissection should be kept above to sulcus in order to prevent bile duct injury.
- The relationship of identification of Rouviere's Sulcus with ease of performing laparoscopic cholecystectomy is statistically significant.

The operating surgeon must know anatomical variations and "Bailout techniques" in difficult situations to carry out Safe Laparoscopic Cholecystectomy.

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