A prospective study of the laparoscopic anatomy of Calot’s triangle, variations and its surgical implications

Somashekar Gejje, Amrita Hongal, KR Srimurthy, HR Ravishankar, Somyaa Khuller

Consultant Plastic Surgeon, M Ch, Dept of plastic surgery, The Bangalore Hospital, R V Road, Bangalore 560004
Observer, Dept of dermatology, Bangalore Medical College, Karnataka
Consultant, Dept of General surgery, The Bangalore Hospital, R V road, Bangalore 560004
Consultant , Dept of general surgery, The Bangalore Hospital, R V Road, Bangalore 560004
Junior Consultant, Dept Of General surgery, Sagar hospital, Kumarswamy Layout, Bangalore.

ARTICLE INFO

Keywords: Calot’s triangle Laparoscopic cholecystectomy cystic duct common bile duct

ABSTRACT

Calot’s triangle holds the key for a successful gall bladder surgery. It is bounded by cystic duct, right side of the common hepatic duct and liver margin. The relationship of above structures with each other is variable from patient to patient. Anomalies of the hepatic artery and cystic artery in the Calot’s triangle are quite common, occurring in as many as 50% of cases. Furthermore these anatomical variations are compounded by distortions caused by acute inflammatory process. Over the last century technical improvements have made recognition of the vast anatomic variations of this triangle easier. We at our centre did a prospective study between February 2011 and May 2013 on 50 consecutive laparoscopic Cholecystectomies.

Anatomy of the Calot’s triangle, its variation and surgical implications were appreciated by careful watching of the Digital Video Discs recordings of the patients who underwent laparoscopic cholecystectomies. Their postoperative course, follow up details were recorded and Statistical analysis was done. Observations showed that the anomalies of the calot’s triangle are more common present in >50% of our series. The ease of dissection was more in patients who had laparoscopic cholecystectomies within 48-72 hours of the onset of symptoms in case of acute cholecystectomies. The duration of the surgery was the shortest in cholecystolithiasis cases. It was shorter in cases of acute cholecystitis who were taken for surgery within 48-72 hours of onset of symptom than the cases who were taken after 48-72 hours. In conclusion, on evaluation and statistical analysis, the variations of the Calot’s triangle was found in >50 % of cases. Thorough knowledge of laparoscopic anatomy of Calot’s is essential and recognition of variations should make surgeon circumspect and cautious. Presence of anatomical variations whilst providing surgical challenge and excitement will not necessarily affect the final outcome, if necessary caution and care are applied.

1. Introduction

Calot’s triangle holds the key for a successful gall bladder surgery. It is bounded by the cystic duct, the right side of the common hepatic duct and the liver margin.

In 1891, Calot described a triangular anatomic region [Fig 1] formed by the common hepatic duct medially, the cystic duct laterally, and the cystic artery superiorly.[1] Calot’s triangle is considered by most to comprise the triangular area with an upper boundary formed by the inferior margin of right lobe of liver; rather than cystic artery.[2,3] It is enclosed by the double layer of peritoneum, which forms the short mesentery of cystic duct. Since the two layers are not closely opposed, there is an appreciable amount of loose connective tissue within the triangle. It is perhaps better described as a pyramidal space with one apex lying at junction of cystic duct and fundus of gall bladder, one at the porta hepatitis, and two closer apices at the attachment of gall bladder to liver bed, the base of triangle thus lies on the inferior surface of liver.[4] The area of Moosman [5] is a circular area 30 mm in diameter; it fits into the hepato-cystic duct angle.[6]

Beergamaschi and ignjatov [7] reported on the surgical ramifications of the occurrence of multiple anatomic structures within Calot’s triangle. Inadvertent ligation of variant veins or bile ducts may complicate laparoscopic cholecystectomy. Stremple [8] estimated that 85% of all variations in the hepatic pedicle are found in Moosman’s area and 50% of these variations are a potential hazard during cholecystectomy.
Within the boundaries of the hepatocystic triangle and of Moosman’s area are the several structures that must be identified in laparoscopic cholecystectomies such as, Cystic duct, cystic artery, common bile duct, right hepatic artery, aberrant hepatic artery (if present).

**Cystic duct**

The neck of the gall bladder continues into the cystic duct which is 2-3 cm long and 2-3 mm in diameter. It runs backwards, downwards, and to the left to join the common hepatic duct, usually in front of the right hepatic artery and its cystic branch. The wall of the neck where it joins the cystic duct may show a small diverticulum (Hartmann’s pouch). This is not a feature of the normal gall bladder and is always associated with a pathological condition, it may be the site of impaction of a gall stone.

The cystic duct contains a series of 5 to 12 crescent shaped folds of mucosa similar to those seen in the neck of the gall bladder. These form the so-called spiral valve of Heister. The valves do not have a valvular function. The valves may cannulation of the cystic duct difficult.

The cystic duct joins the hepatic duct at an angle of about 400 in 64-75% of individuals. In 17-23%, the cystic duct parallels the hepatic duct for a longer or shorter distance and may even enter the duodenum separately. This is called the absence of the common bile duct. In 8-13%, the cystic duct may pass inferior to or superior to the common hepatic duct to enter the latter on the left side. In the parallel type of junction, the common bile duct is at risk from the surgeon attempting to ligate the cystic duct. Less frequently, the gall bladder is sessile with little or no cystic duct.

**Cystic artery**

The cystic artery usually arises as a single branch from the right hepatic artery within calot’s triangle. It traverses the hepatocystic triangle to the right of the common hepatic duct. The lymph node of calot usually lies just superficial to the position of the cystic artery in the cystic triangle, and can be a good guide to finding and ligating it. Reaching the gall bladder behind the common hepatic duct, the cystic artery branches into an anterior superficial and a posterior deep branch. These branches anastomose and send arterial twigs to the adjacent liver.

Infrequently the cystic artery may arise from the left hepatic artery, common hepatic artery, the gastroduodenal artery or the superior mesenteric artery. In approximately 25% of the subjects, the superficial and the deep branches arise separately.

The deep branch usually comes from the right hepatic artery. The superficial branch may spring from the right hepatic, left hepatic, gastroduodenal, or retroduodenal artery. The extra hepatic bile ducts are supplied from the cystic artery.

In most individuals (96%), the cystic artery is found in the hepatocystic triangle. Among 220 cadavers examined by Michel’s the cystic artery was double in 50 and triple in one. Michel’s described 20 possible patterns of the origin of double cystic arteries.[Fig 3]

The relationship of the above structures with each other is variable from patient to patient. Anomalies of the hepatic artery and the cystic artery which are associated with Calot’s triangle are quite common, occurring in as many as 50% of cases.

(Table 1). Furthermore these anatomical variations are compounded by distortions caused by acute inflammatory process as in acute cholecystitis, fibrosis as found in chronic contracted gall bladders and adhesions to neighbouring structures like stomach, duodenum and colon.

Over the last century a number of technical improvements were made to identify this triangle so as to avoid injury to the vital structures of the hepatic hilum.

Some of them are cholecystotomy, ante grade cholecystectomy, suberosal cholecystectomy, subtotal cholecystectomy, on table operative cholangiogram and cholecystectomy, deliberate common bile duct exploration and cholecystectomy.

Since the introduction of laparoscopic cholecystectomy in 1987 by Phillipe Mooret in Lyon, France, there has been an explosive growth of gall bladder surgery worldwide.

Initially this was associated with a high rate of injury to common bile duct, vessels etc due to lack of appreciation of the laparoscopic two dimensional anatomy of the Calot’s triangle. Strange equipments, patient’s position, lack of tactile feel, uncontrolled energy devices created additional operating hazards to the operating surgeon. Over a course of time, with the appreciation of the laparoscopic anatomy, familiarity with the equipment like energy devices, good lighting and magnification, the incidence of common bile duct injuries have come down substantially.

The improvements made in the last century have made a remarkable change in the successful out come in gall bladder surgeries and minimized common bile duct injuries.

Latest literature survey in open cholecystectomy has shown that the common bile duct injuries to be between 0.1% and 0.2%. The mortality in open cholecystectomy is less than 1% across all ages. In laparoscopic cholecystectomies morbidity rates range from 1.5-8.6% and bile duct injuries range from 0.2-0.7%.

In this study I am going to highlight the laparoscopic anatomy, variations and discuss the surgical implications in consecutive series of 50 laparoscopic cholecystectomies.
Material and Methods

Study was conducted in the operation theatre, our digital video library analyzing the digital video discs and the postoperative wards during the postoperative period. The Bangalore Hospital, Bangalore, Karnataka.

This study was conducted on urban patients aged between 20-80 years who underwent laparoscopic cholecystectomies for gall bladder pathologies from February 2011 till May 2013. An informed consent was obtained from all the patients and the ethical principles were not violated.

Study was conducted on 50 adult patients with gall bladder pathologies requiring laparoscopic cholecystectomies under general anaesthesia. The anatomy of Calot’s triangle, its variations were analyzed by carefully watching the digital video disc recordings of the patients who underwent laparoscopic cholecystectomies.

The data was collected in three forms. First the digital video disc recordings of the patients who underwent laparoscopic cholecystectomies, secondly the inpatient files of the same patients till the time they stayed in hospital, and later the out patient follow up of the same patients coming for the review.

All the patients who had laparoscopic cholecystectomy done for cholecystolithiasis, acute calculous cholecystitis, chronic cholecystitis with cholelithiasis, and acalculous cholecystitis were included in the study.

A prospective study was done between February 2011 and May 2013. Pts admitted to The Bangalore hospital during above-mentioned period for laparoscopic cholecystectomies were selected. Clinical diagnosis was made after clinical history and physical examination.

Relevant and adequate pre-operative work up investigations and medical fitness for surgeries were obtained. Each patient was informed about the procedure and informed consent was obtained. Laparoscopic Cholecystectomy done through conventional 3 port technique

Post operatively patients were observed for 4-6 hours in the postoperative ward. They were started on clear liquids the same evening. The patients were invariably started on normal diet and discharged on the second day. The resected specimens of the gall bladder were sent for histopathological examination and pus for culture sensitivity.

The anatomy of the Calot’s triangle, its variation and surgical implications were appreciated by careful watching of the Digital Video Discs recordings of the patients who underwent laparoscopic cholecystectomies. Their postoperative course and follow up details were recorded.

Data analysis

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean  SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. 2x4 Fisher Exact test has been used to find the significance of study parameters on categorical scale between two groups. 90% Confidence Interval has been computed to find the significant features. Confidence Interval with lower limit more than 50% is associated with statistical significance.

The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables

Results and Discussion

In this prospective study, a total of 50 patients were evaluated between February 2011 and May 2013. After the detailed history, physical examination, investigations, clinical diagnosis was made. These patients underwent pre-operative work up and were subjected to laparoscopic cholecystectomy after physician’s fitness for surgery.

The digital videodiscs (DVD) of the cases were analysed carefully and the anatomy, variations and surgical implications were studied.

The age range of patients in this study was between 20-80 years, the mean age being 48.46 years.

The incidence of overall gall bladder pathology was found in 31 female cases (72%) compared to 19 male cases (38%).

The age wise distribution in commonest diagnosis (cholecystolithiasis) was 4 cases (14.8%) in age group 20-30, 8 cases (29.6%) in age group 31-40, 5 cases (18.5%) in 41-50, 4 cases (14.8%) in 51-60, 3 cases (11.1%) in 61-70, & 2 cases (7.4%) in 71-80.

The female sex had more incidence of the cholelithiasis. 19 out of 27 cases of cholecystolithiasis were females. The sex wise distribution in the most common diagnosis i.e., cholecystolithiasis in age groups were 3 females (75%) and 1 male (25%) in age group 20-30, 3 males (36.9%) and 5 females (63.1%) in 32-40, 1 male(20%) and 4 females (80%) in 41-50, 2 males (50%) and 2 females (50%) in 51-60, 1 male (33.3%) and 2 females (66.6%) in 61-70, 1 male(50%) and 1 female (50%) in 71-80 years.

The largest study to date is of the Danish population.[29] Five-year incidence rates of gallstones in men ages 30, 40, 50, and 60 years were 0.3%, 2.9%, 2.5%, and 3.3% respectively. The corresponding rates for women were 1.4%, 3.6%, 3.1%, and 3.7%. Woman clearly had a higher incidence rate than men at ages 30 and 40 years, but the difference disappeared with rising age.
Overall gallstones are nearly twice as common in females as in males. [30] The change in the relative incidence rates between men and women suggest that estrogen has a role in the greater secretion of the cholesterol into bile that occurs in young women. [31]

Among the gall bladder diseases the most common was the cholecystolithiasis with 27 cases (54%), acute calculous cholecystitis the second commonest accounting for 16 cases (32%), chronic cholecystitis with 6 cases (12%), least common was acalculous cholecystitis with 1 case (2%).

The mean duration of surgery (laparoscopic cholecystectomy) in all cholecystolithiasis cases was 37.8 minutes. The duration of one case of cholecystolithiasis where laparoscopic procedure was converted to open procedure (hepatico-duodenostomy) for accidental common bile duct injury was 150 minutes. The mean duration of the surgery in acute cholecystitis that were taken for surgery with 48-72 hours of presentation was 52.7 minutes than compared to 64.1 minutes who underwent operation after 48-72 hrs of presenting symptoms. In one case of acute calculous cholecystitis the duration was 120 minutes, the reason being conversion of laparoscopic procedure to open one, due to distorted anatomy, dense adhesions and difficult dissection of Calot's triangle. The mean duration was 55 minutes in chronic cholecystitis and 50 minutes in acalculous cholecystitis.

The average operating time of simple laparoscopic cholecystectomy is 21.5 minutes and for difficult cholecystectomies, it is 58.0 minutes. [32]

The gall bladder looked red (inflamed) was seen in almost all cases of acute cholecystitis except one in case, one case cholecystolithiasis, 2 cases if chronic cholecystitis.

There were adhesions between gall bladder, liver, omentum in almost all cases of acute cholecystitis except one, 3 cases of chronic cholecystitis with cholelithiasis, 4 cases of cholecystolithiasis. [Fig 4] Adhesions were breakable with ease in cases of acute cholecystitis that were operated within 48-72 hours and were dense, vascular, fibrosing in cases operated later than 48-72 hours.

Ease of dissection was maximum in cases of cholecystolithiasis and least in acute calculous cholecystitis of more than 72 hrs of onset of symptoms due to dense vascular adhesions.

In the first 72-96 hours of the symptoms, the inflammatory changes around the gall bladder tend to be edematous, with the tissue planes preserved, thus facilitating removal of the gall bladder. After this time frame, the acute inflammatory reaction progresses and matures with fibrotic changes predominating obliteration tissues. [33] The adhesions will be more dense and vascular in patients of acute cholecystitis who are taken for surgery after 48-72 hours.

In our series of 50 cases few obvious findings and a total of 15 variations were found. [Table 2] [Graph 1]

Emphesamatus gall bladder as a complication of acute cholecystitis was seen in 3 cases as a complication of acute calculous cholecystitis, mucocoele of gall bladder in a case of cholelithiasis, contracted gall bladder in a case of chronic cholecystitis, nodular liver and ascites in a case of compensated liver cirrhosis were the glaring obvious findings in our series.

One study [34] has shown that acute cholecystitis resolves without complications in approximately 83% of patients but results in gangrenous cholecystitis in 7%, gall bladder empyema in 6%, perforation in 3%, and emphesamatus cholecystitis in less than 1%.

Short cystic duct, wide cystic duct, short and wide cystic duct, long cystic duct, absent Cystic duct, high junction of the cystic duct with the common hepatic duct, low junction of the cystic duct with the common hepatic duct, cystic duct joining common hepatic on the left, tented prominent common bile duct which looked like cystic duct, double cystic artery, cystic artery from the left hepatic artery, wide common hepatic duct, cystic artery parallel to right hepatic artery, Cystic artery anteriorly placed to cystic duct, cystic artery parallel to right hepatic artery were seen as variations.

Cystic duct being short in one case was mistaken for common bile duct and clipped, cut. Absent cystic duct in 1 case of chronic cholecystitis resulted in subtotal cholecystectomy by extracorporeal ligation. In 3 cases of acute cholecystitis the cystic duct was ligated (two extra corporeal, one intracorporeal) after retrograde dissection. In one case of acute calculous cholecystitis it was ligated because it was wide.

The low and high confluences of the cystic duct to the common hepatic duct made dissection little longer than usual. The relation could not be made out in 4 cases of acute calculous cholecystitis and 1 case of chronic cholecystitis with cholelithiasis, the reason being adhesions and inflammation. In one case unusual joining of the cystic duct to the left of the common hepatic duct was seen as it was long, curving, joining to left.

A short cystic duct is seen frequently and may be draining into the right hepatic duct or a low-entry right sectoral hepatic duct (2%) or common hepatic duct (1%) or connect the infundibulum with the common bile duct by a duct only few millimeters in length in 5% to 6% of cases. [35] During laparoscopic cholecystectomy, these ducts are in danger of being mistaken for a normal cystic duct and divided. [36]

The cystic artery was found in Calot's triangle in 80% of cases. It could not be isolated in 4 cases as inflammation and adhesions masked it. In our series we found one case where cystic artery originated from the left hepatic artery and was not found in Calot's triangle.

One of the most frequent anomalies is a right hepatic artery that loops up onto the infundibulum of the gall bladder, which can be misidentified as the cystic artery, leading to the hepatic artery ligation. [37]
Adhesions between cystic duct and the common hepatic duct seen in 10 cases of acute calculous cholecystitis made dissection difficult and time-consuming.

The variations in cystic duct, cystic artery, and common hepatic duct, accessory choledochohepatic ducts were seen in 58% of cases in various combinations. The variations in the cystic duct accounted for the most percentage of variation in our series, with one major complication (common bile duct transection) due to its short length and common bile duct being tented. The distorted anatomy of Calot's with dense vascular adhesions in one case of acute calculous cholecystitis made us convert the laparoscopic procedure to an open one.

Studies where the variations of the structures of the Calot's triangle were found have been mentioned below, which are comparable to our study.

In one study [38] series, six hundred patients treated with laparoscopic cholecystectomy from June 2005 to May 2006 were studied retrospectively. Laparoscopy has revealed there are many anatomic variations of the cystic artery that occur frequently.

Based on their experience with 600 laparoscopic cholecystectomies, they presented a new classification of anatomic variations of the cystic artery, which can be divided into three groups:

Group 1 showed the cystic artery passing within Calot's triangle. It included two types: (1) single cystic artery, found in 440 patients (73.3%); and (2) double cystic artery, observed in 73 patients (12.2%).

Group 2 showed the cystic artery situated outside Calot's triangle. This group included four variations: (1) cystic artery originating from the gastroduodenal artery, found in 45 patients (7.5%); (2) cystic artery originating from the variant right hepatic artery, found in 18 patients (3%); (3) cystic artery directly arising from the liver parenchyma, observed in 15 patients (2.5%); and (4) cystic artery originating from the left hepatic artery.

Group 3 had a compound appearance, with the variant cystic artery situated not only within Calot's triangle, but also outside it.

The conclusion drawn was classification of the anatomic variations of the cystic artery would be useful for decreasing uncontrollable cystic artery hemorrhage, and avoiding extrahepatic bile duct injury.

Study [39] regarding the variation of the junction of cystic duct and hepatic duct.

In one study from 1999 to 2000, 33 fetuses were dissected. Using pictures to register the cystocholedochohepatic junctions, they were classified as high, medial and low, and the course type in parallel or angular. The cystocholedochohepatic junction was visualized in 93.9% of the fetus, the medial insert in 45.2% of them, the high insert in 29.0% and the low one in 25.8%. Concerning the ductal course, the angular union was present in 71% of the fetus, while the parallel was in 29%. About the length of the ducts, the cystic duct varied from 4 to 6 mm, the common hepatic duct from 9 to 13 mm and the choledochal duct from 5 to 10 mm.

Conclusions drawn were, concerning anatomic variations, the medial insertion was prevalent associated with angular course. Mean length of the cystic and common hepatic ducts was 6 and 7 mm, respectively. This study demonstrated a significant frequency of cysticohepatic low junctions.

The postoperative course was eventful in the form of fever on second postoperative day in 1 case of acute cholecystitis which subsided on medication. In three cases of acute calculous cholecystitis where dissection was difficult due to inflammation and adhesions, drains were kept in the subhepatic spaces, which were taken out on day 2 in 2 cases and day 3 in 1 case. In 1 case of choledocholithiasis with mucocoele where the fluid spilled during aspiration, a drain was kept which was removed on second postoperative day. In one case of choledocholithiasis where laparoscopic converted open cholecystectomy with hepaticoduodenostomy performed, the drain was removed on the fourth postoperative day.

In our series only one case of bile duct injury (accidental clipping and transaction) occurred in a case of laparoscopic cholecystectomy for choledocholithiasis as the cystic duct was short, common bile duct tented up looking prominent. The leak was identified on table and laparotomy with hepatico-duodenostomy performed.

In 50 laparoscopic cholecystectomies performed in our series two cases were converted to open method, first one in a case of acute cholecystitis of more than 5 days duration, the second one in cholecystitis which was converted to an open one due to accidental Common Bile Duct Injury.

Study regarding the risk factors needing conversion to an open cholecystectomy.

In this study [40] 1,000 laparoscopic cholecystectomies performed at Ankara Numune Hospital, Fourth Department of Surgery, from March 1992 to July 1999 were prospectively analyzed. The patients studied included 804 women (80.4%) and 196 men (19.6%) with a mean age of 43.8 years (range, 30-80 years). The factors available to the surgeon preoperatively were considered for analysis. These factors included age, gender, history of acute cholecystitis, jaundice or pancreatitis, previous abdominal surgery, obesity and concomitant disease, white blood cell (WBC) count, preoperative liver function tests, ultrasound findings of the gallbladder, preoperative endoscopic retrograde cholangiopancreatography (ERCP), and suspicion of common bile duct stones. Of the 1,000 patients in whom laparoscopic cholecystectomy was attempted, 48 (4.8%) required conversion to open surgery. The most common reason for conversion was inability to define anatomy in patients with inflamed contracted gallbladder (n = 34).
Significantly independent predictive factors for conversion were male gender, previous abdominal surgery, acute cholecystitis, thickened gallbladder wall on preoperative ultrasonography, and suspicion of common bile duct stones.

Conclusion drawn was, an appreciation for the aforementioned predictors of conversion would allow appropriate planning by the patient, the institution, and the surgeon.

In our series of 50 cases the morbidity was 10%, conversion rate was 4%, bile duct injury 2%, mortality -0%.

The findings of our series are comparable to the results of two series of studies of laparoscopic cholecystectomies.

Study[41]. Number of patients-10174, morbidity rate-10.4%, mortality rate-0.2%, Bile duct injury-0.31%, conversion rate-8.2%

Study[42]. Number of patients 114005, morbidity rate-5.4, mortality rate 0.06%, Bile duct injury-0.5%, and conversion rate-2.2%

The mean duration of stay of cases of acute calculous cholecystitis, operated < 48-72 hours was 3.8 days, mainly due to prolonged pain. In one case it was 4 days because of conversion of laparoscopic surgery to an open one. In one more case of acute calculous cholecystitis the stay time in hospital was 7 days as the patient had other comorbidities such as type II diabetes mellitus, hypertension, and chronic renal failure. The mean duration of stay for the cases of acute calculous cholecystitis, operated > 48-72 hours was 4.2 days. The mean duration of stay in cases of cholelithiasis was 2.2 days. In one case of cholelithiasis with mucocoele where drain was kept the patient went home on 4th day. In one more case of cholelithiasis where hepatico duodenostomy was performed due to accidental injury of common bile duct the duration of stay was prolonged to 6 days. The duration of stay was three days in the case of acalculous cholecystitis.

Patients undergoing simple laparoscopic cholecystectomy are discharged within 24 hours while those undergoing difficult cholecystectomy are discharged in 2-4 days depending on their general condition.[43]

**Fig 1- Calot’s triangle**
Table 1- Segments of the Biliary Tract and the frequency of arteries lying anterior to them

<table>
<thead>
<tr>
<th>Segment</th>
<th>Artery Anterior</th>
<th>Percent Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Right and left hepatic duct</strong></td>
<td>Right hepatic artery</td>
<td>12-15</td>
</tr>
<tr>
<td><strong>Cystic artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Common hepatic duct</strong></td>
<td>Cystic artery</td>
<td>15-24</td>
</tr>
<tr>
<td><strong>Right hepatic artery</strong></td>
<td></td>
<td>11-19</td>
</tr>
<tr>
<td><strong>Common hepatic artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Supraduodenal common bile duct</strong></td>
<td>Anterior artery to CBD</td>
<td>50</td>
</tr>
<tr>
<td><strong>Posterosuperior Pancreatic -</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>- duodenal Artery</strong></td>
<td></td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Gastroduodenal artery</strong></td>
<td></td>
<td>5.7-20.*</td>
</tr>
<tr>
<td><strong>Right gastric artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Common hepatic artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Cystic artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Right hepatic artery</strong></td>
<td></td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Retroduodenal common bile duct</strong></td>
<td>Posterosuperior Pancreatic -</td>
<td>76-87.5</td>
</tr>
<tr>
<td><strong>- oduodenal Artery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Supraduodenal artery</strong></td>
<td></td>
<td>11.4</td>
</tr>
</tbody>
</table>

*In another 36 percent, the gastroduodenal artery lay on the left border of the common bile duct (Maingot, 1974).

CBD: Common bile duct.

TABLE 2: Obvious findings and Variations

<table>
<thead>
<tr>
<th>Obvious findings variations</th>
<th>Number (n=50)</th>
<th>%</th>
<th>90% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSENT</td>
<td>21</td>
<td>42.0</td>
<td>31.22-53.60</td>
</tr>
<tr>
<td>PRESENT</td>
<td>29</td>
<td>58.0</td>
<td>46.40-68.78</td>
</tr>
<tr>
<td>WIDE CD</td>
<td>6</td>
<td>12.0</td>
<td>6.33-21.57</td>
</tr>
<tr>
<td>LONG CD</td>
<td>4</td>
<td>8.0</td>
<td>3.64-16.67</td>
</tr>
<tr>
<td>SHORT CD</td>
<td>4</td>
<td>8.0</td>
<td>3.64-16.67</td>
</tr>
<tr>
<td>SHORT AND WIDE CD</td>
<td>3</td>
<td>6.0</td>
<td>2.42-14.09</td>
</tr>
<tr>
<td>EMPHEMATOUS GALL BLADDER</td>
<td>3</td>
<td>6.0</td>
<td>2.42-14.09</td>
</tr>
<tr>
<td>CA ANT to CD</td>
<td>3</td>
<td>6.0</td>
<td>2.42-14.09</td>
</tr>
<tr>
<td>GB CONTRACTED</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>CD PARALLEL TO CHD</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>HIGH JTN OF CD WITH CHD</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>NODULAR LIVER</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>ASCITIES</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>PROMINENT TENTED CBD CONFUSED WITH CD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>DOUBLE CYSTIC ARTERY</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>CD JOINING CHD ON THE LEFT</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>WIDE CHD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>LOW JTN OF CD WITH CHD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>MUCOCOELE DISTENDED GB</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>ABSENT CD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>CA PARALLEL TO RHA</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
</tbody>
</table>

Graph 1: Pie chart showing obvious findings / variations

Graph 2: Pie chart showing normal and abnormal final anatomy

TABLE 3: FINAL ANATOMY

<table>
<thead>
<tr>
<th>FINAL ANATOMY</th>
<th>Number (n=50)</th>
<th>%</th>
<th>90%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL</td>
<td>21</td>
<td>42.0</td>
<td>31.22-53.60</td>
</tr>
<tr>
<td>ABNORMAL</td>
<td>29</td>
<td>58.0</td>
<td>46.40-68.78</td>
</tr>
<tr>
<td>WIDE CD</td>
<td>6</td>
<td>12.0</td>
<td>6.33-21.57</td>
</tr>
<tr>
<td>SHORT CD</td>
<td>4</td>
<td>8.0</td>
<td>3.64-16.67</td>
</tr>
<tr>
<td>SHORT AND WIDE CD</td>
<td>3</td>
<td>6.0</td>
<td>2.42-14.09</td>
</tr>
<tr>
<td>CA ANT to CD</td>
<td>3</td>
<td>6.0</td>
<td>2.42-14.09</td>
</tr>
<tr>
<td>WIDE COMMON HEPATIC DUCT</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>CD PARALLEL TO CHD</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>HIGH JTN OF CD WITH CHD</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>ACCESSORY CHOLECYSTOHEPATIC DUCT</td>
<td>2</td>
<td>4.0</td>
<td>1.33-11.39</td>
</tr>
<tr>
<td>PROMINENT TENTED CBD CONFUSED WITH CD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>DOUBLE CYSTIC ARTERY</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>CD JOINING CHD ON THE LEFT</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>LOW JTN OF CD WITH CHD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>ABSENT CD</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
<tr>
<td>CA PARALLEL TO RHA</td>
<td>1</td>
<td>2.0</td>
<td>0.5-8.48</td>
</tr>
</tbody>
</table>
Conclusions

On evaluation and statistical analysis the variations of the Calot's triangle was found in >50 % of cases. [Table 3] [Graph 2]. Thorough knowledge of laparoscopic anatomy of Calot's is essetntial and recognition of variations should make surgeon circumspect and cautious in proceeding further. Presence of anatomical variations whilst providing surgical challenge and excitement will not necessarily affect the final outcome, if necessary caution and care are applied. The anatomical variations become more critical in acute situations where conversion to open procedure should be considered early, dependent on the comfort level and experience of the surgeon. Whenever Calot's triangle anatomy is not clear or accessible, variations in surgical technique like retrograde or fundus first, sub-total cholecystectomy should be considered. This will eventually lead to demonstration of anatomy and safe performance of surgery. Whilst it is ideal to perform intra-operative cholangiogram in every case it is practically not feasible. Whenever doubts arise as to anatomy or complications happen it is imperative to perform the same to demonstrate the anatomy and proceed further. Unusual insertions of cystic duct should be handled with diligence so as to not adversely affect the blood supply of common bile duct or inadvertently injure it. Alternative methods like intra or extra corporeal suturing of the cystic duct stump should be considered whenever need arises. Alternative retractive facilities should be utilized when gall bladder is deeply embedded or lobes of liver are overhanging the gall bladder and obstructing the access. Review of the literature shows complications rates following laparoscopic cholecystectomy have followed the learning curve of the surgeon and recognition of unusual anatomy comes with thorough laparoscopic knowledge and experience.

Recommendations

1. Variations in anatomy of Calot’s triangle are commonly encountered in laparoscopic cholecystectomies in more than 50% of patients.

2. Thorough knowledge of the anatomy of Calot’s triangle and its variations, will avoid injuries to the vital structures like Common bile duct and hepatic artery.

3. Acute or chronic inflammatory conditions of gall bladder further obscures and distorts anatomy of Calot’s triangle adding to difficulty during laparoscopy. Surgeon must a low threshold for conversion keeping in view of the safety of patient.

4. Surgeons should be open to alternative procedures such as subtotal, antegrade cholecystectomies operative cholangiogram, and Common bile duct exploration in cases of difficult dissection due to distorted anatomy of Calot's.

5. Complication rates following laparoscopic cholecystectomy have followed the learning curve of the surgeon. The first 50-100 cases carry higher risk of common bile duct injury or arterial injuries. We recommend young surgeons to be careful while doing laparoscopic cholecystectomies, identify all vital structures like Common bile duct, hepatic artery, portal vein and cystic duct catarzeing or clipping.

6. Presence of adhesions due to previous upper abdominal surgery is not necessarily a contraindication for routine laparoscopic cholecystectomy. An open port well away from the scar tissue will give good view of adhesions which can be released before undertaking a laparoscopic cholecystectomy.

REFERENCES


08 Streple JF: The need for careful operative dissection in Moosman’s area duringcholecystectomy. Surg Gynecol Obstet 1975; 141:769.


22 Michels NA: The hepatic, cystic, and retrodudenal arteries and their relations To the bilet ducts with samples of the entire celiac blood supply. Ann Surg 133:563, 1951.


39 Santiago, Michael Silveria; Santiago, Tatiana Silveria; Melo, Valdinaldo Angoode et all. Anatomic variability of the junction between cystic and common hepatic ducts in fetus. Acta Cir Bras. 2003; vol18, n.1, p.p. 01-09.
