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Incidence of Vascular and Biliary Anomalies Found during Laparoscopic Cholecystectomy and their Outcomes

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Abstract: ***Introduction: Cholecystectomy is one of the most performed abdominal operations in general surgery. Recognition of biliary structures during laparoscopic procedures requires a greater familiarity of anatomy than for a standard or open procedure. Variations in the anatomy of gallbladder, bile ducts and the arteries that supply them and liver are important to the surgeon because failure to recognize them may lead to inadvertent ductal ligation, biliary leaks, and strictures after laparoscopic cholecystectomy. Congenital anomalies of extra hepatic biliary tree have long been recognized but are rare. Of the complications associated with laparoscopic cholecystectomy, the most potentially significant are those of injury to the vasculature or biliary tract which occur in 0.25% and 0.6% of procedures respectively. Variations in biliary anatomy are common, with 19-39% of the population having a variation of "normal" biliary anatomy12. Less than 2% of cases of cholecystectomy need to be converted from laparoscopic to open due to uncontrollable hemorrhage and approximately 0.16% cases of laparoscopic cholecystectomy are complicated by injury to significant hepatic vasculature, such as hepatic artery or portal vein. Recent advances in MRI, MRCP and Multidetector (MD) or Helical CT Scan have improved image quality greatly and have contributed to increased recognition.***

Keywords: Gall Bladder, Hepatobiliary anomalies, Vascular anomalies

1. Introduction

Anatomy is the only solid foundation of medicine; it is to the physician and surgeon what geometry is to the astronomer. It discovers and ascertains truth, overturns superstition and vulgar error, and checks the enthusiasm of theorists and experts in medicine, to whom, perhaps more of the human species have fallen a sacrifice than to the sword itself or to a fatal epidemic disease. Considerable clinical experience accumulated over the past several decades has demonstrated that the traditional cholecystectomy may be performed with a low operative morbidity and mortality

- Cholecystectomy is one of the most performed abdominal operations in general surgery.
- Recognition of biliary structures during laparoscopic procedures requires a greater familiarity of anatomy than for a standard or open procedure.
- Variations in the anatomy of gallbladder, bile ducts and the arteries that supply them and liver are important to the surgeon because failure to recognize them may lead to inadvertent ductal ligation, biliary leaks, and strictures after laparoscopic cholecystectomy
- Congenital anomalies of extra hepatic biliary tree have long been recognized but are rare
- Of the complications associated with laparoscopic cholecystectomy, the most potentially significant are those of injury to the vasculature or biliary tract which occur in 0.25% and 0.6% of procedures respectively
- Variations in biliary anatomy are common, with 19-39% of the population having a variation of "normal" biliary anatomy12 . Less than 2% of cases of cholecystectomy need to be converted from laparoscopic to open due to uncontrollable hemorrhage and approximately 0.16% cases of laparoscopic cholecystectomy are complicated by injury to significant hepatic vasculature, such as hepatic artery or portal vein
- Recent advances in MRI, MRCP and Multidetector (MD) or Helical CT Scan have improved image quality greatly and have contributed to increased recognition of these entities. These investigations do not provide any information regarding the vascular anatomy.
- Thus, the only way out is to dissect and delineate every vascular and ductal structure in each patient irrespective of anatomy and anomalies

Aims

To study the incidence of variations in vascular and biliary anatomy found during laparoscopic cholecystectomy and its complications.

Objectives

1) To evaluate the type and frequency of anatomical variations in biliary and vascular structures during laparoscopic cholecystectomy.
2) To compare various difficulties which occur during dissection of the anomalies.
3) To study the intra-operative complication

2. Methodology

The present study was carried out in the department of General Surgery, Kamineni Institute of Medical Sciences, Narketpally. The study included 50 patients who were admitted and underwent laparoscopic cholecystectomy during the period from October 2020 to October 2022.

Inclusion Criteria

- All patients who were clinically and radiologically diagnosed with symptomatic cholelithiasis/chronic calculouscholecystitis and undergone laparoscopic cholecystectomy in General Surgery department, KIMS.
- Patient age >10 and < 70 years.

Exclusion Criteria

1) Patients with:
   - Acute Pancreatitis
   - Obstructive jaundice
   - Acute cholecystitis
   - Empyema gall bladder
2) Patients who were not willing and unfit for surgery
3) Patients with bleeding diathesis

All patients were evaluated by history and clinical examination. After informed consent, all patients were operated (laparoscopic cholecystectomy) under General Anesthesia. Parameters assessed were the type of biliary and vascular anomalies, the age group and gender, the intra operative complications, the duration of surgery, post-operative complications. Certain observations were made.

3. Results

- The incidence of cholelithiasis is more in the age group of 41-50 years (30%) and therefore more laparoscopic cholecystectomies were done in the same age group. The youngest patient was 18 years, and the oldest patient was 69 years.
- In this study of 50 cases, 34% were males and 66% were females. • it suggests that incidence of cholelithiasis is more in females than males.

Distribution of Biliary and Vascular Anomalies among Cases (n=50)

Anatomy	Number of patients	Percentage	p- value
Normal	39	78%	0.74(NS)
Variationinbiliaryanatomy	8	16%	
Variation in vascularanatomy	3	6%	
Total	50	100%	

- It is found that anomalies were seen in 11 cases (22%), suggesting that it is not very uncommon to encounter an anomaly while performing laparoscopic cholecystectomy.
- Slightly a greater number of biliary variations (16%) were seen compared to arterial variations (6%).
- In cases undergoing laparoscopic cholecystectomy more anomalies were seen in young age(18-30years) 54.5%.variations in biliary and vascular anomalies were slightly more common in males (54.5%). Biliary anomalies occurred more in males (62.5%) than females (37.5%). The vascular variations are seen slightly more in females (66.7%).
- >2hrs of operating period was seen in 22% of cases, 1-2 hrs. In 62% of cases and<1 hr in 16% of cases
- The operating time is increased in 54.5% of cases with anomalies
- The p value is 0.026 which is significant. Chi Square Value=16.35, Hence in cases with anomalies duration of surgery is increased significantly

Distribution of Cases among type of Variations (Intra OP findings) (n=50)

Intra OP Findings	Frequency	Percentage (%)
Normal	39	78.0
Short Cystic Duct	2	4.0
Anterior Insertion of Cystic Duct into CHD	1	2.0
Cystic Artery Present Anterior to Cystic Duct	1	2.0
Double Cystic Arteries	1	2.0
Double GB	1	2.0
Duct of Luschka	1	2.0
Absent cystic duct	1	2.0
Long Tortuous Cystic Duct with Low Insertion into CHD	1	2.0
Low insertion of Cystic Duct into CHD	1	2.0
Moynihan's Hump of Right Hepatic Artery	1	2.0
Total	50	100

Distribution of cases in relation to complications (n=50)

Complication	No. of cases
NO	47
Injury to Biliary Tree	1
Vascular Injury (Bleeding)	2
Liver Injury	0
Bowel Injury	0
Total	50

From the above table it is found that among the complications which occurred, 2 were vascular and 1 was biliary injury.

Distribution of intra-OP complications among cases with normal anatomy and variations (n=50)

Intra OP findings	Yes	No	P value
Normal Anatomy	2	37	0.65(NS)
Biliary Variation	1	7	
Vascular Variation	0	3	

From the above table it is found that among the complications occurred in cases with variations was seen only in one case.

- p=0.65(not significant)
- Chi Square Value=0.84

Distribution of cases in relation to laparoscopy to open conversion (n=50)

Lap to Open Conversion	Frequency	Percentage (%)	Reason
Yes	2	4.0	Difficult Dissection Due To Frozen Calot's Triangle
No	48	96.0	-

From the above table it is found that 2 cases (4%) were converted from laparoscopy to open cholecystectomy due to difficult dissection due to frozen calot's triangle.

4. Discussion

Ever since the introduction by Philippe Mouret in France, laparoscopic cholecystectomy is now gold standard for the

management of symptomatic gallstones disease. It is now offered to all corners with a success rate of 99%. Exposure of hepatobiliary triangle remained main domain of the study. The use of laparoscopy for gallstone disease with high resolution and magnification reveals clear anatomy of biliary tree as compared to open cholecystectomy. Therefore, extra hepatic biliary system can easily be assessed for its anatomical variations and congenital anomalies during laparoscopic cholecystectomy. The overall incidence of these anomalies found in the present study is 22%.

Comparison of Total Variations with Other Studies

Studies	Present study (n=50)	Shubhrashankha Sen et al. (2020) (n=200)	Khamiso et al (2010) (n=300)	Hasan et al (2013) (n=250)	Lutfi et al (2013) (n=15 0)	Masroor et al (2016) (n=150)
Total Variations	22%	25%	24.66%	15.2%	54%	7.6%
Cystic Duct	12%	10%	4.33%	5.6%	12%	-
Accessory cystic duct	2%	-	-	-	-	
Arterial	6%	7%	20.33%	8%	40%	7.6%
Gall Bladder	2%	8%	-	1.6%	2%	-

Comparison of number of biliary and arterial variations with other studies

Variation	Present study	Shubhrashankh a Sen et al (2020)	Khamis o et al (2010)	Hasa n et al (2013)	Lutfi et al (2013)	Masroo r et al (2016)
Biliary	16%	18%	4.33%	7.2%	14%	-
Arterial	6%	7%	20.33%	8%	40%	7.6%

In the study greater number of biliary variations were seen whereas in studies done by Khamiso et al., and Lutfi et al., more arterial variations were seen.

Comparison of Extra-Hepatic Biliary Tree Variations (%)

Studies	Extra-Hepatic Biliary tree abnormality (%)
Present Study	16
Shubhrashankha Sen et al. (2020)	18
Hasan et al. (2013)	7.2
Cochoeira et al (2012)	7.3
Philippo et al (2008)	8.8
Kullman et al (1996)	19

It is recommended that surgeons properly identify the EHBT anatomy intraoperatively to avoid injuries. There are very few studies in the existing literature that looked at the association between abnormal anatomy of extra- hepatic biliary tree and genders. According to this study, the association seems to be statistically insignificant ($p>0.05$).

The key abnormality found in gall bladder was a double gall bladder in 2% subjects. A proportion (2.86%) of cylindrical shaped GB and 2.86% of Flask shaped GB was observed by Nadeem et al., [34] in UAE; and van Eijick et al.,[35] found a very high prevalence of Hartmann's pouch (52%) in their study.

Comparison of cystic artery variations

Studies	Present Study	Shubhrashankha Sen et al. (2020)	Maron et al (2019)	Andall et al (2016)	Kamath (2016)	Lutfi (2013)	Khamiso (2010)
Prominent Anterior branch (%)	-	2.5	-	5.4	-	16	2.67
Accessory Cystic Artery (%)	-	1	-	-	-	18	1
Double cystic artery	2	-	-	-	-	-	-
Cystic artery present outside the calot's triangle (anterior to the cystic duct)	2	-	-	-	-	-	-
Moynihan' s hump (%)	2	0.5	1.3	-	5	-	-

The present study found cystic artery having an abnormal anatomy in 6% of the subjects.

Arterial Variations

The arterial anomalies should be recognized during laparoscopic cholecystectomy to prevent arterial bleeding and hence iatrogenic injuries. The most dangerous anomaly is tortuous course of common hepatic artery or right hepatic artery on the front of the origin of cystic duct known as "Cater pillar turn or Moynihan's hump"[36].

In a study done by Doherty GM., et al., (2006), the vascular anomalies assessed in the study were 6% out of which 2% revealed Moynihan's hump. The most important thing is the short cystic artery arising from the looped right hepatic artery[37] and most vulnerable to trauma during cholecystectomy. 15% of cases right hepatic artery and cystic artery cross infront of the common hepatic and cystic duct[36] whereas Gupta RL (2003) published that accessory cystic artery is found in 20% of cases[38] and the variations in the course of cystic artery found in this were artery present outside the calot's triangle (artery crossing anterior to cystic duct) in 2%.

Bhanasali SK et al, reported that the variations in number of cystic arteries like double cystic artery is seen in 2% of cases whereas single cystic artery is present in 85% of cases[39]. Double cystic artery was seen in 1% of cases. No Aberrant cystic artery was seen.

Leghari AA et al, reported that due to these anatomical variation's complications seen were bleeding in 6 % of case. Two patients were re-explored. No mortality was seen[40].

However, morbidity assessed by minor biliary leaks in other cases could be due to accessory Cholecystohepatic ducts passing directly into the liver bed which are unusual[41] and not recognized during laparoscopic procedure

5. Summary

This study was carried out to assess the incidence of anatomical and congenital anomalies of extrahepatic biliary system and vascular anomalies in patients undergoing laparoscopic cholecystectomy. 50 patients diagnosed as a case of cholelithiasis undergoing Laparoscopic cholecystectomy were assessed for anatomical and congenital anomalies of extra hepatic biliary system and vascular anomalies. Structures mainly assessed for anomalies were gall bladder, cystic duct, cystic artery and hepatic artery which are routinely handled during cholecystectomy. However, assessment of variations and anomalies, of hepatic ducts, portal vein, retro duodenal and pancreatic parts of CBD were not done due to possibility of iatrogenic injuries.
50 cases of cholelithiasis comprising 33(66%) females and 17(34%) males with mean age of 42.14 years were included in the study. Operative findings revealed variations in 11cases (22%) mainly involving cystic artery (6%), cystic duct (12%), gall bladder (2%), accessory biliary ducts (2%). Intra operative complications were seen in 3(6%) but were managed laparoscopically. The operating time is increased in 54.5% of cases with anomalies. 2 cases (4%) were converted from laparoscopy to open cholecystectomy due to difficult dissection due to frozen calot's triangle. No mortality was seen in this series. Anatomical and congenital anomalies of biliary tree are not uncommon and are significant during surgery as failure to recognize them leads to iatrogenic injuries and can increase morbidity and mortality.

6. Conclusion

Laparoscopic cholecystectomy is usually a low-risk procedure associated with a short stay and a low rate of conversion to open surgery. Complications are associated with anomalous vascular or biliary anatomy. The unpredictability of extra-biliary anatomy combined with inflammation and fibrosis at times distorts the existing anatomy. This may lead the surgeon into an 'error trap' of misidentification and misperception of biliary structures and is the frequent cause of BDI. To overcome the dilemma of 'mis identification' surgeons should be aware of the arrangement of vascular and biliary structures in the Calot's region. This can be possible only if the types of anomalies which can occur during surgery are well known.

Main findings of current study confirmed that the detailed information of the boundaries and contents of hepatobiliary triangle and its variable ductal and vascular patterns is of huge significance for the diagnostic and therapeutic success as it makes surgical approaches more focused and technically perfect.

Conversion to laparotomy, in difficult cases involving inflammatory changes, aberrant anatomy or excessive bleeding, is not to be considered as a failure but rather as good surgical decision to ensure the patient's safety.

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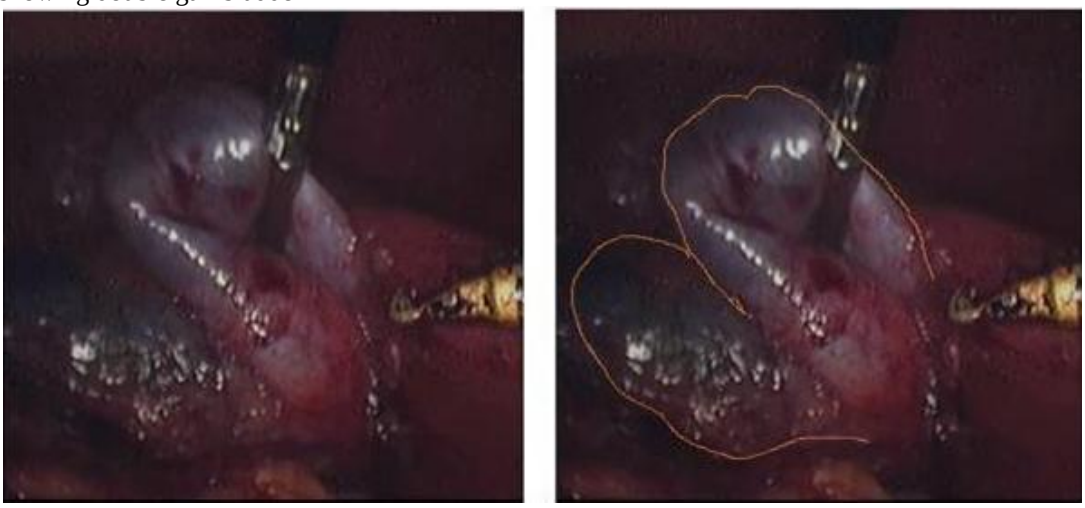
Photographs

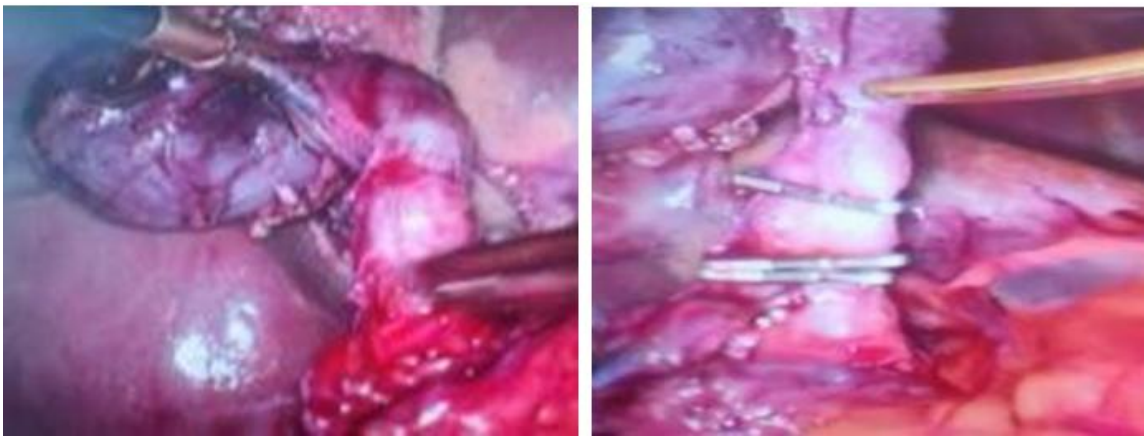
1) Image showing double gall bladder



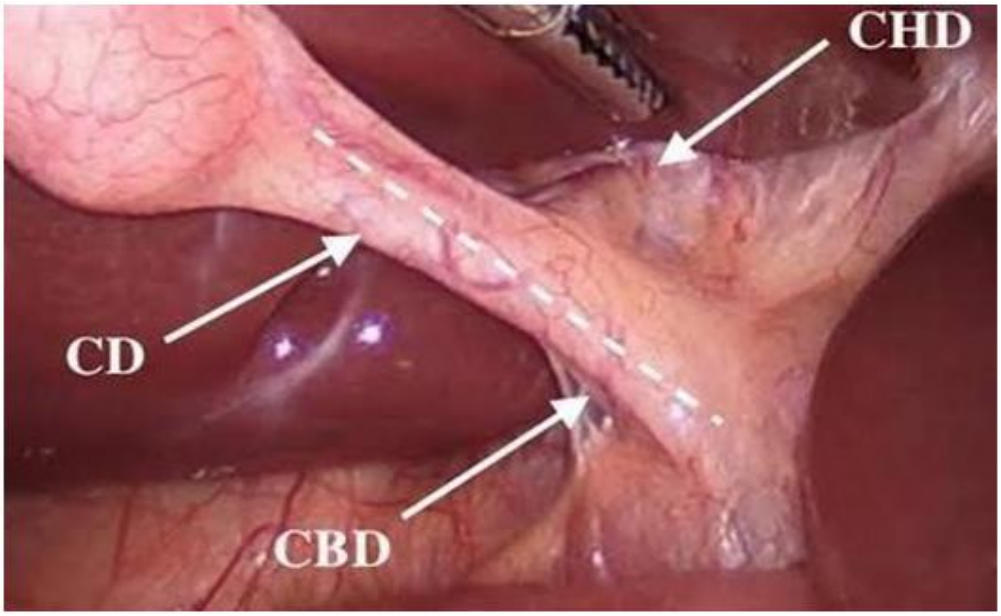
2) Image Showing Short Cystic Duct

3) Image Showing Short Cystic Duct

4) Image Showing Long and Tortuous Cystic Duct with Low Insertion into CHD

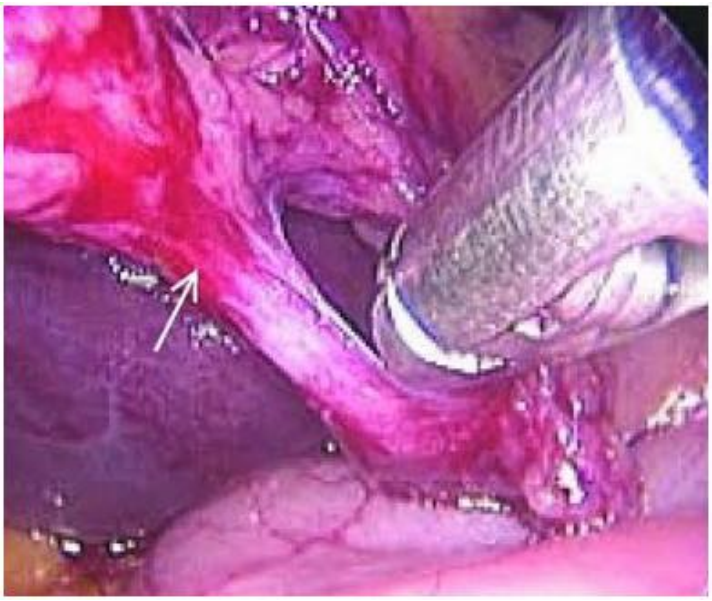


5) Image showing anterior insertion of cystic duct into CHD

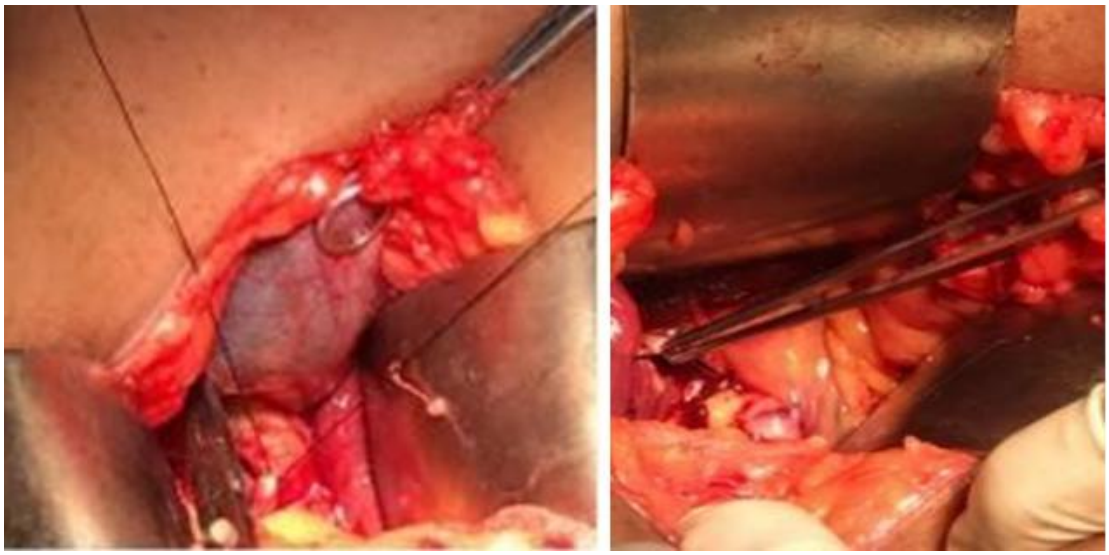


6) Image Showing Absent Cystic Duct

7) Image Showing Low Insertion of Cystic Duct

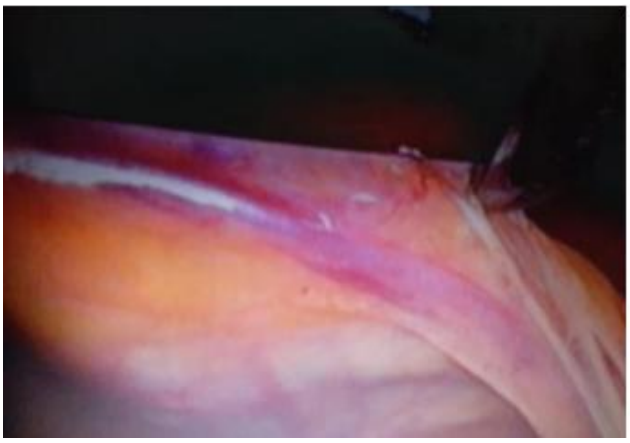


8) Image Showing Duct of Luschka



9) Image Showing Double Cystic Arteries

10) Image showing cystic artery present outside the calot's triangle




11) Image Showing Moynihan's Hump of Right Hepatic Artery