ANATOMICAL VARIATIONS IN EXTRA-HEPATIC BILIARY TREE AND VASCULATURE ENCOUNTERED DURING CHOLECYSTECTOMY

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Abstract

Aim and objectives: The surgeon must recognize variations in the gallbladder, bile ducts, arteries that supply them, and liver to prevent unintentional ductal ligation, biliary leaks, and strictures after cholecystectomy. This study's objective was to investigate the structural changes that take place in the extrahepatic biliary tree and vasculature after cholecystectomy by comparing pre- and post-operative images.

Materials and method: This Prospective Intraoperative observational study was conducted in the department of General Surgery, Santosh Medical College and Hospital from July 2021 to June 2022. The sample size was calculated to be 139 patients. Common Hepatic Duct formation, Right and left hepatic duct union, Types of cystic-hepatic duct union, Cystic duct and common hepatic duct, duct length, Hepato-duodenal ligament structures, Ductal variations, Arterial, duct, and Calot's triangle variations.

Results: Majority (31.8%) belonged to 26-35 years followed by 36-45 years (29.1%), 46-55 years (18.9%), Above 55 years (10.8%) and 15-25 years (9.5%). There were 26.4% males and 73.6% females. Calot was frozen among 23.0% and Accessory artery in calot was found among 2.0% subjects. The anomalies were Aberrant right hepatic artery (0.7%), Accessory artery (1.4%), Double cystic duct (0.7%), Empyema (8.8%), Gb polyp (0.7%), Micro Gallbladder (0.7%), Mucocele (1.4%), Necrosed gall bladder (1.4%), Phregian cap (0.7%), Pyocele with moynihan hump (0.7%) and Type 2 bile duct injury (0.7%).

Conclusion: Short cystic duct and intrahepatic gall bladder alterations are most common. Cholecystectomy discloses extrahepatic biliary problems. Every surgeon should watch for these variations to avoid unintended ductal cutting, ductal injuries, and haemorrhage during laparoscopic and open cholecystectomy.

Keywords: Aberrant right hepatic artery, Calot, Cholecystectomy, gall bladder

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

INTRODUCTION

EHBT surgery is a common surgical treatment. Anatomical changes in this system occur between 7.3% and 47% of the time.[1] During laparoscopic cholecystectomy, the surgeon must discover variations in the gallbladder, bile ducts, and feeding arteries, as well as the liver. Inadvertent ductal ligation, biliary leakage, and strictures can ensue.[2,3] Congenital extrahepatic biliary tree anomalies have been recognized for a long time,[4] despite the fact that they are uncommon4 and may be clinically significant[5] due to the fact that they have the potential to shock surgeons during laparoscopic cholecystectomy. [6]

In addition, there are a few varieties of the anatomy that occur far less often and are more complicated.[7] Cholelithiasis is a common surgical ailment that may be treated completely by cholecystectomy. This condition can be seen all over the world. Surgeons are sometimes taken aback by the high incidence of extrahepatic biliary tree congenital anomalies, despite the fact that cholecystectomy is one of the most commonly performed major surgical procedures.

Cholelithiasis, cholecystitis, gallbladder atresia, and malignant neoplasms of the gallbladder or biliary tract are common extrahepatic biliary system illnesses. Gallbladder inflammation is cholecystitis.[9] In humans, jaundice frequently indicates gallbladder or extrahepatic biliary organ illness; abdominal effusion may indicate bile peritonitis. Jaundice yellows skin and eyes. If an effusion has 10 times more bilirubin than the serum, bile is leaking into the abdominal cavity, a surgical emergency.[10]

Surgeons must be aware of differences in the region's vascular supply when performing a typical cholecystectomy or biliary tree procedure. Sometimes a pair forms between the cystic artery and duct, which are anterior and superior to the CBD. Possibly near the cystic duct.[11-14] During a laparoscopic cholecystectomy, one of the most challenging complications that might occur is bleeding from the cystic artery. This is due to the fact that bleeding diminishes overall visibility in the abdomen. There has been a reported 6.62 percent incidence of blood vessel injury leading to the need for conversion to open surgery.[15] Young surgeons who just started using laparoscopic procedures have trouble accessing Calot's triangle. Iatrogenic injuries in this region are a major cause of morbidity during open or laparoscopic cholecystectomy. Laparoscopic cholecystectomy research has focused on classifying Calot's triangle structures. An auxiliary cystic artery may develop from the main or right hepatic artery. Incomplete vision before dissection of the cystic artery can put other important arteries at risk during open or laparoscopic cholecystectomy. Cystic artery course and location relative to other structures is variable. The cystic artery is visible inside hepatic ducts and behind the main duct. Up to 95% of the time, the cystic artery starts from the right hepatic artery and runs parallel to the cystic duct.[16]

In 33% cases, it begins in the common hepatic artery or, less often, the celiac trunk. In 16% of cases, the artery is behind the hepatic duct. If more distal, it begins in the celiac trunk. In some cases, the artery runs parallel to the CBD, which causes complications for surgeons undergoing cholecystectomy. Rarely (0.3% of patients) have a triple gallbladder arterial supply, while 12% have auxiliary cystic arteries. A patient with a triple arterial supply to the gallbladder is rare.[17] These anatomical variants account for 9.6% to 54% of the variance, according to research. This study aimed to reduce the amount of damaged bile ducts.[18] Variations in the gallbladder, bile ducts, and arteries that feed them, as well as the liver, must be detected by the surgeon to prevent inadvertent ductal ligation, biliary leaks, and strictures after cholecystectomy. The surgeon must also be familiar with gallbladder, bile duct, and feeding artery anatomy. These variations must be known before laparoscopic cholecystectomy; nevertheless, preoperative identification by normal examinations is difficult and only detected in uncommon

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

circumstances. They are sometimes surprise discoveries after laparoscopic surgery. Radiologic testing can identify pancreatic and biliary abnormalities.[19] This study's objective was to investigate the structural changes that take place in the extrahepatic biliary tree and vasculature after cholecystectomy by comparing pre- and post- operative images.

1. MATERIALS AND METHOD

This Prospective Intraoperative observational study was conducted in the department of General Surgery, Santosh Medical College and Hospital from July 2021 to June 2022. The sample size was calculated to be 139 patients.

The study was conducted using following parameters: formation of Common Hepatic Duct, Site of union of right and left hepatic ducts, Types of union of cystic duct with common hepatic duct, Level of termination of cystic duct with common hepatic duct, Length of the individual ducts, Course and arrangement of structures in Hepato- duodenal ligament, Variations in Ductal system, Variations in arterial system related to duct system and Calot's triangle.

Inclusion Criteria

- All patients undergoing cholecystectomy in general surgery department between 18- 65 years of both sexes

Exclusion criteria

1. Patients below 18 and above 65 years of age
2. Carcinoma Gall Bladder
3. Post-surgical case of Upper Abdomen
4. Not giving consent

Study procedure

After approval from the Institutional Ethical committee all patients were selected as per inclusion and exclusion criteria. A detailed history, complete physical examination and routine & appropriate investigations were done for all patients.

Statistical analysis

SPSS version 21.0 was used to analyse the Microsoft Excel data. Quantitative variables (numerical) were mean and SD, while qualitative variables (categorical) were frequency and %. The student t-test was used to compare mean values, whereas the chi-square test compared frequency. p-values less than 0.05 were considered significant.

2. RESULTS

Table 1: Age and Gender Distribution

Age	Frequency	Percent
15-25 years	14	9.5%
26-35 years	47	31.8%
36-45 years	43	29.1%
46-55 years	28	18.9%
Above 55 years	16	10.8%

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

Total	148	100.0%
Mean±SD	40.73±12.26 (14-73)	
Male	39	26.4%
Female	109	73.6%
Total	148	100.0%

Table 2: Calot's anatomy (intra-operative finding)

Calot	Frequency	Percent
Normal	111	75.0%
Frozen calot	34	23.0%
Accessory artery in calot's	3	2.0%
Total	148	100.0%

Table 3: Anomalies

Anomaly	Frequency	Percent
No anomalies	139	93.9%
Accessory artery	2	1.4%
Aberrant right hepatic artery	1	0.7%
Double cystic duct	1	0.7%
Gb polyp	1	0.7%
Micro Gallbladder	1	0.7%
Phregian cap	1	0.7%
Moynihan hump	1	0.7%
Type 2 bile duct injury	1	0.7%
Total	148	100.0%

Table 4: Diagnosis

Diagnosis	Frequency	Percent
Cholelithiasis	99	66.8%
Chronic Cholecystitis with Cholelithiasis	26	17.6%

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

Acute Calculous Colecystitis	9	6.08%
Acute on Chronic Cholecystitis with Cholelithiasis With Empyema	3	2.0%
Choledococholelithiais	3	2.0%
Acute Calculous Cholecystitis with Mucocele	1	0.7%
Cholelithiasis With Cld	1	0.7%
Cholelithiasis With Incisional Hernia	1	0.7%
Cholelithiasis With Liver Hemangioma	1	0.7%
Cholelithiasis With Umbilical Hernia	1	0.7%
Cholelithiasis With Ventral Hernia	1	0.7%
Gb Polyp with Adenomyomatosis	1	0.7%
Necrosed Gall Bladder	1	0.7%
Total	148	100.0%

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

3. DISCUSSION

Variations are the result of developmental anomalies in the embryo.[20] A ventral bud (hepatic diverticulum) forms the liver, gallbladder, and biliary tree in the fourth week. The pars hepatica is the liver's primordium, whereas the pars cystica becomes the gallbladder and cystic duct.[21,22] This protrusion spreads as rapidly growing cell strands into the septum transversum and separates between ventral mesentery layers.

In current study, majority (31.8%) belonged to 26-35 years followed by 36-45 years (29.1%), 46-55 years (18.9%), Above 55 years (10.8%) and 15-25 years (9.5%). Jarrar et al.[23] had a mean age of 43 years with extremes of 11 and 83 year. Das S. et al.[24] found that the patients' mean age was 42.5 years, while the median age was 41.5 years.

In North-African studies, the average age of the literature ranged from 35 to 46 years.[25-27] It ranged from 16 to 89 years in other studies, with a range of 30 to 57 years.[28-30] Jarrar et al.[23] reported that age varied from 11 to 89 years old, with a mean of 49. Age and the prevalence of anatomical variations did not correlate, according to our research.

If we accept that variances are caused by anomalies in embryological development, as has previously been demonstrated, then this is totally understandable. The maljunction of the pancreatico-biliary tract, in particular, has been documented to be associated with gender-variant extra-hepatic biliary morphology.[31,32]

In present study, there were 26.4% males and 73.6% females. Jarrar et al.[23] stated that consisted predominantly of women (68.6%) against a male percentage of 31.4%. Sex ratio M/F was 0.46. Das S. et al.[24] found that 56.66 percent were girls and 43.33 percent were men, with a female to male ratio of 1.5:1.

According to an Italian research,[29] females were much more likely to have a variable anatomy (45% vs. 26% in men; p=0.005). This discrepancy may be explained by the two sexes developing embryologically differently. However, a lack of evidence cannot support this idea. Jarrar et al.[23] reported that the gender ratio was 0.45, with 68.6% of the participants being women and 31.4% being men. Gender was not correlated with variant anatomy.

In the study by Khan et al., 82.7% of the study's participants were female, while 17.3% were men.[33] Das et al.[24] stated that the female patients made up 56.66% of the patient population while male patients made up 43.33%.

In our study, Calot was frozen among 23.0% and Accessory artery in calot was found among 2.0% subjects. None of the subjects had Fever, Wound infection/ discharge and Keloid/ hypertrophic scar.

Das et al.[24] stated that Right hypochondrium pain was the most prevalent presenting symptom (73.33%), followed by right hypochondrium pain with discomfort in the epigastrium, epigastrium pain, nausea, vomiting, and dyspepsia. The common intra operative complication was bleeding which occurred in 2 patients out of 60 patients and in both the patients had anatomical variations in EHBS.

Right hypochondriun pain was more prevalent in the Talapur et al.[34] study (71.67%), however the Sheikh et al study found that right hypochondriun pain was more prevalent when combined with epigastric discomfort (71.3%).

Khayat et al.[35] found that 15% of biliary tract injuries were recorded, which is greater than in earlier studies. This might be explained by the increased prevalence of aberrant anatomy there. The authors discovered a relationship (P = 0.04) between aberrant anatomy and biliary tract damage. Hasan et al.[36] observed the same connection with a biliary tract damage incidence of 6%. Krahenbuhl Kallman et al. both found lower incidences of 0.5% and 0.3%, respectively.[37] In order to prevent damage, it is advised that surgeons correctly identify the

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

EHBT anatomy intraoperatively.

In present study, the anomalies were Aberrant right hepatic artery (0.7%), Accessory artery (1.4%), Double cystic duct (0.7%), Empyema (8.8%), Gb polyp (0.7%), Micro Gallbladder (0.7%), Mucocele (1.4%), Necrosed gall bladder (1.4%), Phregian cap (0.7%), Pyocele with moynihan hump (0.7%) and Type 2 bile duct injury (0.7%).

Anandhi et al.[38] stated that in 2% of subjects, it was aberrant. The main anomalies discovered were the cystic duct joining the left side of the common hepatic duct, abnormalities in the position and division of the right and appropriate hepatic artery, and abnormalities in the position and division of the cystic artery. 2% of the individuals had Calot's triangle borders that were abnormal. Accessory hepatic ducts are one of the Calot's triangle's abnormal components in 10% of patients. 2% of the participants each had a double cystic artery, an aberrant auxiliary cystic artery, and a cystic arterial branch from the right hepatic artery outside the triangle.

Shaikh B et al.[39] discovered that Intrahepatic gall bladder in 12 cases, floating gall bladder in 2 cases, phyragian cap gall bladder in 3 cases, short cystic duct in 10 cases, long cystic duct in 7 cases, accessory cholecystohepatic duct in 5 cases, Moynihans hump in 2 cases, cystic artery anterior to cystic duct in 5 cases, cystic artery posterior to cystic duct in 4 cases, short cystic 9 of the 50 patients who had these defects detected after surgery had operational issues

Koshariya M. et al[40] Most common modification in extrahepatic biliary apparatus was short cystic duct (6%) followed by intrahepatic development of common hepatic duct (3%) 1% of cystic ducts were introduced into the common hepatic duct. In 1% of cases, the cystic artery was anterior to the common hepatic duct. In 2% of cases, the pancreas' anterior vascular arcade was absent or had a different origin. In 1% of cases, the posterior pancreatic arcade was absent, and origin was variable. 22% of patients had a different pancreatic duct route.

Devi et al.[41] discovered accessory hepatic ducts in 17% of the participants whereas Khayat et al.[35] detected them in just 3.33% of the subjects.[19,20] Laparoscopic cholecystectomies cause bile duct damage twice as often as open ones, so it's important to know about accessory hepatic ducts.

Sen S et al.[42] found that around 10% patients showed cystic duct variations, 18% showed extra-hepatic biliary tree variations, and another 7% patients showed arterial variations. They found around 10% patients (one-fourth) showed cystic duct variations, 18% showed extra-hepatic biliary tree variations, and another 7% patients showed arterial variations which is comparable and analogous to previous incidence rate.

In 2% of cases in the Sharma et al.[43] investigation, an abnormal cystic artery was found. Gall bladder variants, such as intra hepatic gall bladders and short cystic ducts, are seen in 4% of individuals. In our analysis, aberrant cystic artery, which accounts for 5% of all cystic arterial alterations, was the second most prevalent anatomical variation outside of the liver.

4. CONCLUSION

Short cystic duct and intra hepatic gall bladder changes are the most frequent, followed by cystic artery variations. Cholecystectomy reveals the majority of extra hepatic biliary system structural abnormalities. Therefore, to avoid unintentional ductal cutting, ductal injuries, and bleeding issues during laparoscopic and open cholecystectomy, every surgeon should watch out for these variances. By being aware of these variances, patients will have less morbidity, conversion, and re-exploration.

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