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Original Research Article

Anatomical Variations of Cystic Ducts in Magnetic Resonance Cholangiopancreatography: A Retrospective Study With 265 Patients

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ABSTRACT

Background: Anatomical variations of cystic duct (CD) are frequently unrecognized. It is important to be aware of these variations prior to any surgical, percutaneous, or endoscopic intervention procedures.

Objectives: The purpose of our study was to demonstrate the imaging features of cystic duct and its variants using magnetic resonance cholangiopancreatography (MRCP) and document their prevalence in our population.

Materials and Methods: This study included 265 patients who underwent magnetic resonance cholangiopancreatography due to different indications and variations of cystic duct were documented.

Results: Normal lateral insertion of cystic duct at middle third of common hepatic duct was seen in 29.43% of cases. Medial insertion was seen in 2.63% of cases, 2.26% were low medial insertions. Low insertion of cystic duct was noted in 1.51 % of cases. Parallel course of cystic duct was present in 0.38% of cases. High insertion was noted in 0.38% cases and no case of short cystic duct was noted. No case of cystic duct draining into right hepatic duct was seen.

Conclusion: Cystic duct variations are common and MRCP is an optimal imaging modality for demonstration of cystic duct anatomy.

KEY WORDS: Cystic Duct, Hepatic Duct, Variation, MRCP.

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INTRODUCTION

The cystic duct is around 2-4 cm in length and 2-3 mm in diameter [1]. It connects the gallbladder neck to common hepatic duct and forms the common bile duct [2]. The site of entry of cystic duct into

common hepatic duct varies. Usually it joins the middle third of the total lengths of the common hepatic and common bile ducts at the right lateral position [1]. The cystic duct varies in length, course and site of meeting with the common hepatic duct. The common anatomical variations of cystic duct of clinical importance are (i) low insertion of cystic duct, (ii) parallel course of cystic duct with common hepatic duct, (iii) anterior or posterior spiral course with medial insertion, (iv) absent or short cystic duct (length < 5 mm), (v) aberrant drainage of cystic duct to right hepatic or left hepatic duct, (vi) aberrant or accessory intrahepatic ducts draining into cystic duct, (vii) double cystic duct [3-5], (iv) anterior or posterior spiral insertion of cystic duct (viii) a very long cystic duct, (ix) a cystic duct arising from the common bile duct, but ending in the gall bladder fundus [6], (x) a cystic duct may be fused with the common bile duct, (xi) rarely, the cystic duct lies along the free edge of the lesser omentum to the level of the duodenum before it merges with the common hepatic duct [7]. The cystic duct can be visualized by a variety of imaging techniques, but it is best to visualize it by direct cholangiography or magnetic resonance cholangio pancreato graphy. The cystic duct anomalies can cause image confusion and make subsequent surgical procedures, endoscopy and percutaneous intervention more difficult [8].

The aim of our study is to identify the anatomical variations of cystic duct in magnetic resonance cholangiopancreatography in this population of North East India.

MATERIALS AND METHODS

Type of study: Observational retrospective study

Place of study: Department of Radiology, Gauhati Medical College and Hospital, Guwahati, Assam.

Duration of study: From August 2017 to July 2018.

Sample size: 265

Sample collection: The MRCP plates were collected from the Department of Radiology, Gauhati Medical College and Hospital, Guwahati, after obtaining ethical clearance from the Institutional Ethical Committee.

Inclusion criteria: Patients aged between 18 and 70 years, of both sexes and referred with provisional diagnosis of cholecystitis and choledocholithiasis.

Exclusion criteria: Post cholecystectomy cases, cases with ductal pathology and cases with overlapping of structures were excluded from the study.

Method: MRCP is usually performed with heavily T2-weighted sequences by using fast spin-echo or single-shot fast spin-echo software and both a thick-collimation (single-section) and thin-collimation (multi-section) technique with a torso phased-array coil. Machine used for MRCP 1.5 Tesla MRI Machine Somatom (TIN) Avanto, Make: Siemens.

The length, course, and insertion of cystic duct were noted. When cystic duct meets the common hepatic duct at the upper third it was noted as high insertion, when it meets common hepatic duct at lower third it was noted as low insertion, when it meets to the right of common hepatic duct it was noted as lateral and when it meets to the left of common hepatic duct it was noted as medial. Site of insertion was also recorded as anterior and posterior. When the length of cystic duct was less than 5 mm it was recorded as short cystic duct and when it was parallel with common hepatic duct for at least 2 cm it was recorded as long parallel insertion.

Statistical methods: Tabulation and analysis of the data was done in Microsoft Excel sheets. In the study specialized statistical methods were not used as the study was an observational retrospective study and no comparison was performed.

Funding: The study was self-financed.

RESULTS

We evaluated MRCP images of 265 patients. Among 265 patients, 123 (46.4%) cases were male patients and 142 (53.6%) were female patients (mean age, 44 years; range, 18–70 years). As represented in table no.1, normal lateral insertion of cystic duct at middle third

of CHD was found in 78 (29.4%) cases and spiral course with medial insertion of cystic duct was recorded in 7 (2.6%) cases. Moreover, low insertion of cystic duct was noted in 3 (1.1%) cases and 6 (2.3%) cases had low medial insertion. Parallel course of cystic duct was present in 1 (0.3%) cases and high insertion of cystic duct was found in 1 (0.3%) cases (table no.1). No cases of absent cystic duct, short cystic duct, parallel course of cystic duct with CBD, cystic duct draining into RHD, aberrant drainage to segment VI duct, aberrant intrahepatic duct draining into cystic duct were noted.

Table 1: Distribution of normal and anatomical variations of cystic duct.

Sl no	Type of cystic duct insertion	Frequency (n=265)	Percentage (%)
1	Normal OR right lateral OR lateral insertion	78	29.43
2	Low right lateral OR low lateral insertion OR low insertion (Figure no.2)	4	1.51
3	Left lateral OR medial insertion	7	2.63
4	Low medial insertion	6	2.26
5	High OR high right lateral insertion (Figure no.1)	1	0.38
6	Anterior insertion	19	7.17
7	Right anterior insertion	1	0.38
8	Posterior insertion	63	23.8
9	Right posterior insertion	1	0.38
10	Low posterior insertion	3	1.13
11	Antero-medial insertion	3	1.13
12	Antero-lateral OR right antero-lateral insertion (Figure no.4)	4	1.51
13	Low left antero-lateral insertion	1	0.38
14	Postero-medial insertion (Figure no.3)	7	2.63
15	Postero-lateral OR right postero-lateral insertion	60	22.63
16	High right postero-lateral insertion	1	0.38
17	Low postero-medial insertion	1	0.38
18	Low postero-lateral insertion	3	1.13
19	Absent cystic duct	0	0
20	Short cystic duct	0	0
21	Long cystic duct	0	0
22	Double cystic duct	0	0
23	Insertion in right hepatic duct	0	0
24	Insertion in left hepatic duct	0	0
25	Accessory cystic duct draining into right hepatic duct	1	0.38
26	Accessory cholecysto-hepatic duct	0	0
27	Parallel course of cystic duct with common hepatic duct (Postero-lateral and parallel termination)	1	0.38
28	Parallel course of cystic duct with common bile duct	0	0
29	Right postero-sectoral hepatic duct draining to cystic duct	0	0
30	Aberrant drainage to segment VI duct	0	0
31	Aberrant/accessory intrahepatic duct draining into cystic duct	0	0

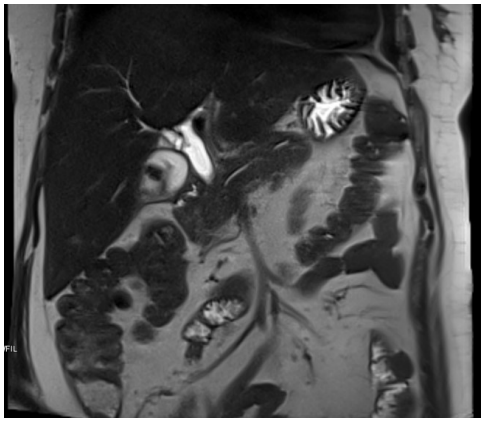

Fig. 1: Cystic duct high insertion.

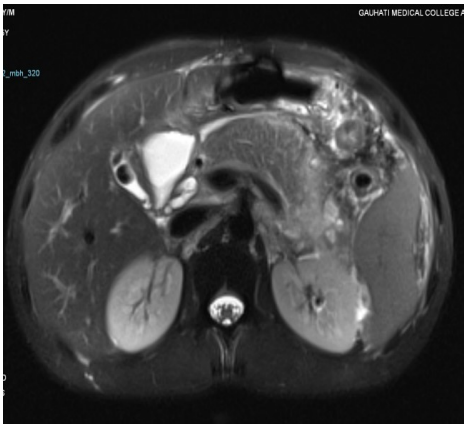

Fig. 2: Cystic duct low insertion.

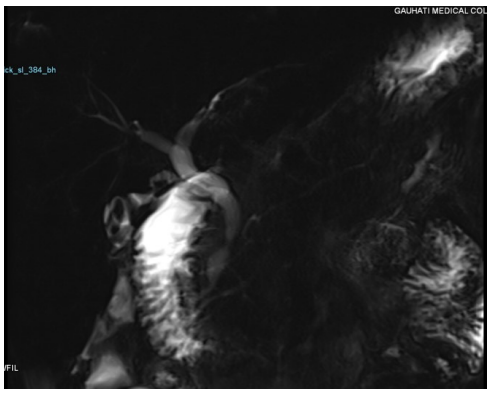

Fig. 3: Postero-medial termination of cystic duct.

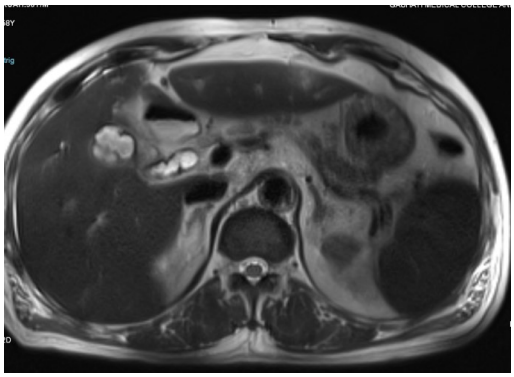

Fig. 4: Antero-lateral termination of cystic duct.

DISCUSSION

Bile duct damage is a significant complication that occurs more frequently during laparoscopic cholecystectomy. Failure to recognize the ductal structure is one of the main causes of bile duct damage, especially in presence of anatomical variations. When common bile duct (CBD) is misinterpreted for cystic duct, it causes complete excision of the common bile duct and it is one of the most feared side effects of both laparoscopic and open cholecystectomy. During cholecystectomy, intraoperative cholangiography (IOC) is often used to describe the bile duct structure. Incomplete bile duct filling and cystic duct protrusion over CBD have resulted in erroneous or ambiguous results [8].

The MRCP is a noninvasive imaging technique for optimally visualizing the cystic duct and bile ducts. According to studies, MRCP offers essential information on the structure of the cystic duct pre-operatively and has a significant protective role on laparoscopic cholecystectomy [15-17].

Prior knowledge of the cystic duct's anatomy and its variations benefits in the appropriate understanding of the disease process and helps to avoid iatrogenic injury. Preoperative knowledge of bile duct morphology may also help in medicolegal purposes [8]. Percutaneous trans-cholecystic biliary interventions through the cystic duct have recently received much interest. Pre-knowledge of the morphology and variations of the cystic duct would be extremely beneficial in planning the treatment and preventing complications [18].

The course of cystic duct and its junction with the extrahepatic bile duct show a lot of variations. In 58 percent to 75 percent of cases, the cystic duct joins the common hepatic duct (CHD) in the middle third from the lateral aspect [19] whereas in the present study 29.43% cases show the similar anatomy as depicted in table no.2. The three most common and clinically significant variants are medial insertion of cystic duct, low insertion of cystic duct, and parallel course of cystic duct. 2.63% of our cases revealed medial insertion with posterior or anterior spiral course (table no.2). In previous studies, medial insertion of cystic duct was observed in 10–18% of instances [20-22]. This variant is important during surgery. Dissection of the medial cystic duct up to its end is risky, it is advisable to leave a long cystic duct remnant [23]. Table no 2 represented that 8 to 11% of cases of previous studies have low insertion of cystic duct (LICD) [20,24,25]. 1.51% of our cases showed LICD and 2.26% had low medial insertion.

Presence of low insertion of cystic duct was linked to higher rate of formation and recurrence of CBD stone [25,26]. Failure to detect a low insertion of the cystic duct may cause technical difficulties and complications during endoscopic retrograde cholangiopancreatography (ERCP) procedures [27].

In 1.2–25% of the population, a long parallel common hepatic duct (CHD) and cystic duct were reported, where these ducts are encased in a fibrous sheath and run in parallel course for at least 2cm [21,23]. This variation was noted in 0.38% in the present study **(table no.2)**. The extrahepatic bile duct can be mistaken for the cystic duct if this variant is not detected, resulting in unintentional section or occlusion of the extrahepatic bile

duct and postoperative complication. The CHD may suffer strictures or constriction if the long parallel cystic duct is ligated or transected too near to it. Long cystic ducts are generally left after cholecystectomy in patients with long parallel cystic ducts and cases with medial insertion. This is more commonly linked with calculus disease and inflammatory changes resulting in post-cholecystectomy syndrome[2]. Short or non-existent cystic ducts are a rare but significant variation that raises the risk of biliary damage, particularly during laparoscopic cholecystectomy [28]. Short cystic duct was reported in 1.3%–2.6% of cases in previous studies [19, 20, 29]. No case of short cystic duct was noted in this study. When surgeons use traction on the gall bladder during surgery to see the cystic duct, the existence of a small cystic duct can result in tenting of the CHD or CBD and unintentional clamping of these ducts [29]. Abnormal draining of the cystic duct into the right hepatic duct is uncommon, occurring in about 0.3 percent to 0.4 percent of individuals [30]. We have also seen aberrant drainage of cystic duct into right hepatic duct in 0.38% cases **(table no.1)**. Because high fusion of the cystic duct into the CHD, anomalous cystic duct drainage into the right hepatic duct, and abnormal fusion of intrahepatic bile ducts to the cystic duct can be mistaken during surgery, resulting in unintentional transaction and ligation, it is important to diagnose these variants. We have not seen any case of double cystic duct in the present study **(table no.1)**. Two cystic ducts with single gall bladder is a very uncommon occurrence and is linked with higher risk of complication in laparoscopic cholecystectomy. This anomaly can be confused with accessory intrahepatic duct draining into the CHD. The need of a preoperative or intraoperative cholangiogram in correctly identifying these variations and avoiding complications is important [4,31].

The optimal imaging technique for determining the anatomy and relationships of the whole biliary system is MRCP. The limitation of our study is that we could not compare our results with ERCP or intraoperative cholangiography. We could not evaluate cystic duct in all patients due to adjacent ductal pathology or overlapping of structures. We will continue this study with more number of patients to identify the cystic duct variations to make the study statistically more significant.

Table 2: comparison of anatomical variations of cystic duct reported by other studies and present studies.

Authors & year	Right lateral (Normal) (In %)	Medial insertion (In %)	Low insertion (low lateral insertion) (In %)	Low medial insertion (In %)	High insertion (In %)	Anterior insertion (In %)	Posterior insertion (In %)	Parallel course of cystic duct (In %)
Cachoiera et al [9] (cadaveric) (2012)	92.7	--	--	--	--	--	--	--
Sarawagi et al[7] (2016) (MRCP)	51	16.1	9	4	5.5	2	20.2	7.5
Talpur et al (laparoscopic cholecystectomy) (2010)	92.8	--	10.7	--	--	3.6	8.9	--
Ashalatha et al [10] (cadaveric) (2017)	84	2	--	--	--	--	--	--
Singh et al [11] (laparoscopic cholecystectomy) (2018)	91.6	--	0.8	--	--	0.4	0.8	--
Rajguru et al [12] (cadaveric) (2018)	76	5	--	--		4	15	--
Gupta et al [13] (laparoscopic+open cholecystectomy) (2019)	77	--	6	--	--	--	--	--
Dandekar et al [14] (cadaveric) (2019)	72	18	6	--	--	--	8	--
Present study (MRCP) (2022)	29.43	2.63	1.51	2.26	0.38	7.17	23.8	0.38

CONCLUSION

Variations in the cystic duct are not uncommon, and it is crucial to know the structura variations. MRCP is a great imaging technique for demonstrating cystic duct structure and variations, which not only aids in appropriate disease interpretation but also serves as a blueprint prior to any percutaneous, endoscopic, or surgical procedures.

Author Contributions

Sushant Agarwal: data collection with collection of reports of MRCP

Pradipta Ray Choudhury: preparing the whole manuscript

Krishna Kanta Biswas: literature search and also help in preparing the manuscript
Prabahita Baruah: statistical part and also help in preparing the manuscript
Abhamoni Baro: data collection and also help in preparing the manuscript

ABBREVIATIONS

CD: Cystic Duct.
MRCP: Magnetic Resonance Cholangiopancreatography.
CBD: Common Bile Duct.
CHD: Common Hepatic Duct.
IOC: Intraoperative Cholangiography.
LICD: Low Insertion Of Cystic Duct.
ERCP: Endoscopic Retrograde Cholangiopancreatography.

Conflicts of Interests: None

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