ORIGINAL RESEARCH

Variations in Cystic Duct Anatomy Using Magnetic Resonance Cholangiopancreatography and their Clinical Significance in Sudanese

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Abstract

Objective: Knowledge on anatomical variations of the cystic duct is important for any surgical, percutaneous and endoscopic intervention procedures. The aim of this study is to determine the normal (typical) and atypical anatomical variations in the cystic duct using magnetic resonance cholangiopancreatography (MRI) at the Fedail Specialized Hospital in Khartoum, Sudan.

Methods: This study is a retrospective evaluation of the cystic duct in 307 patients who were routinely imaged with MRI between November 2019 and March 2021 for various indications. The location, level, and course of the cystic duct were examined. Descriptive and chi-square statistics were used for analysis.

Result: This study included 307 patients aged 6 months to 100 years, of whom 44.3% were males and 55.7% were females. The typical anatomy of the cystic duct was seen in only 30.29% of patients; in contrast reported literature (58–75%). A total of 69.71% showed atypical configurations. The most common variant was high cystic insertion (36.2%). Low insertion (21.8%), low medial insertion (14.6%), a spiral posterior course (15.6%), and a parallel course (0.1%) were also observed. A short cystic duct less than 5 mm in length was seen in 1% of cases. Other rare findings included (0.3% in each): absent cystic duct, spiral anterior course with low medial insertion, spiral anterior then posterior, drainage of cystic duct to the right hepatic duct, drainage of the cystic duct at the junction between the right and left hepatic ducts, very high insertion just below the junction of the right and left hepatic ducts, and a case of common bile and cystic duct. There was no statistically significant difference between males and females with regard to anatomical variations (location; p = 0.740). (height; p=0.671) (course; p=0.678) were observed.

Conclusion: The normal anatomy of the cystic duct is observed in only 30% of cases. Anatomical variations are encountered in 70% of cases, with high insertion of the cystic duct being the main variation followed by low insertion.

Key words: Anatomical variations, Cystic duct, MRI, Sudanese

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Introduction

The extra-hepatic biliary tract is constituted by the right and left hepatic ducts, the common hepatic duct, the gall bladder, the cystic duct, and the common bile duct (1). The right and left hepatic ducts go out from the liver and join to form the common hepatic duct, the latter is united with the cystic duct at an acute angle to create the common bile duct, which is blended with the main pancreatic duct and opening in the middle of the second part of the duodenum at the major duodenal papilla of Vater. However, the neck of the gallbladder carries on as the cystic duct, which is around 2 to 3 cm in length and 3 mm in diameter and exhibiting a tortuous course (2). The anatomy of the biliary tree is complex, and the extra-hepatic biliary tract is subject to multiplicity variations, about 57.6% to 75% of the people having normal biliary anatomy (3).

Low levels of cystic duct (CD) insertion are surgically important and associated with common bile duct (CBD) stone formation and symptomatic recurrence (4). Failure to identify this variation may result in significant problems during endoscopic retrograde cholangiopancreatography (ERCP). A parallel course is defined as a cystic duct that runs parallel to the common hepatic duct (CHD) for at least 2 cm (5).

Cystic duct absences or short lengths are clinically significant variations; the presence of a short cystic duct might cause occlusion of the common hepatic duct or common bile duct as well as accidental clamping of these ducts. Double cystic duct, aberrant drainage to the right or left hepatic duct, aberrant or accessory intrahepatic cystic duct or right hepatic duct draining to the CD, and high union of the cystic duct are all rare variations, but it is essential to detect them early in order to prevent unintentional transaction and ligation (6).

Present study aims to describe variations in cystic duct anatomy using magnetic resonance cholangiopancreatography and their clinical significance in Sudanese patients.

Methods

This is a retrospective descriptive cross-sectional study. This study was conducted at the Fedail Specialized Hospital in Khartoum, Sudan., during the period from November 2019 to March 2021. The study was carried out on 307 patients who were referred to Fedail Specialized Hospital for magnetic resonance cholangiopancreatography (MRCP). All patients attended during the study period determined the sample size.

Ethical approval for the study was obtained by the ethical committee of the Faculty of Medicine and Health Sciences, Omdurman Islamic University. A verbal consent was obtained from the hospital director and the radiology department of Fedail Specialized Hospital.

Inclusion criteria

The study included all patients underwent MRCP in Fedail Specialized Hospital during the period from November 2019 to March 2021.

Exclusion criteria

Motion artifact and inadequate technique, or any patient with a difficult assessment of cystic duct anatomy, a large tumor or pathology distorting the anatomy of the cystic duct, or a grossly distended cystic duct leading to poor anatomical delineation, were excluded from this study.

Data collection tools

Data were collected directly from the picture archiving and communication system (PACS) system by the researcher, and difficult cases were seen by a senior radiologist.

Tracing the cystic duct up to the point of joining with CHD in axial and coronal T2WI, coronal 3D MRCP images, and maximum intensity projection (MIP) images at different planes were performed.

Statistical analysis

Data from the study were analyzed using a Statistical Package for Social Sciences (SPSS) program version 26. The results were explained in tables and figures. The p-value was set at 0.005 or less to determine the statistical significance.

Results

Anatomical variations of the cyst duct using MRI were analyzed in 307 patients who were imaged for different indications. Most important findings are as follows.

Lateral insertion of the cyst duct in the middle of the common hepatic duct was seen in 30.29% of cases; high insertion was seen in 36.2% of cases; low insertion was observed in 21.8% of cases. In 17.9% of cases with medial insertion, spiral course was observed in 15.6% of cases, parallel course was noted in 10.1% of cases, short cystic duct was observed in 1% of cases, and absent cystic duct, cystic duct draining to the right hepatic duct, right posterior sectoral duct draining to the cystic duct, and choledochal cyst are rare findings (0.3% in each).

Table 1 shows the gender distribution and Table 2 shows that the age distribution from 6 months to 100 years: The age group 41–60 years represents a high frequency (39%). The age group 81–100 years had the lowest frequency (2.6%).

Table 1: Frequency distribution of gender

Gender	Frequency	Percent %
Male	136	44
Female	171	56
Total	307	100

Table 2: Frequency distribution of patients according to the age:

Age group (Month/yrs)	Frequency	Percent %
1mnth-20 yrs	11	3.6
21-40	69	22.5
41-60	120	39.1
61-80	99	32.2
81-100	8	2.6
Total	307	100.0

Level of cystic duct insertion

Table 3 shows that the middle insertion of CD has the highest frequency (40.7%), followed by high levels of insertion (36.2%), absent CD, at the junction between the RHD and LHD, or just below the junction, and CD drain to the RHD which have the least frequencies (0.3%) for each.

Table 3: Frequency distribution of level cystic duct of insertion:

Level of CD insertion	Frequency	Percent %
High	111	36.2
Middle	125	40.7
Low	67	21.8
Absent	1	0.3
Junction between the RHD &LHD	1	0.3
Just below the junction	1	0.3
CD drain to the RHD	1	0.3
Total	307	100

Site of CD insertion

Table 4 shows that lateral insertion of the CD is the most frequent site of insertion (58.6%), followed by posterior insertion (17.6%).

Course of cystic duct insertion

Table 5 shows that the tortuous course of the cystic duct has the highest frequency (222 cases, 72.3%), followed by the spiral posterior (15.6%).

Table 4: Frequency distribution of the site of cystic duct insertion:

Site of insertion	Frequency	Percent%
Medial	52	16.9
Lateral	180	58.6
Posterior	54	17.6
Anterior	18	5.9
Absent	1	0.3
At the confluence of hepatic ducts	1	0.3
CD drain to RHD	1	0.3
Total	307	100

Table 5: Frequency distribution of the course of the CD insertion:

Course of insertion	Frequency	Percent%
Tortuous	222	72.3
Spiral posterior	48	15.6
Parallel	31	10.1
Spiral anterior	1	0.3
Short CD	4	1.3
Spiral anterior then posterior	1	0.3
Total	307	100

Rare variations

Table 6 shows rare variations of the cystic duct anatomy, short cystic duct was seen in 4 cases (1%), and other rare findings were seen in one case for each (0.3%).

Table 6: Rare variations in cystic duct anatomy:

Rare anatomical variant	Frequency	Percent %
Short CD	4	1.3
Right posterior sectoral duct drains to CD	1	0.3
Choledochal cyst	1	0.3
CD drain to RHD	1	0.3
Spiral anterior then posterior	1	0.3
Spiral anterior	1	0.3
CD drain at the confluence	1	0.3

Gender significance

Table 7 shows the relation between the site of cystic duct insertion and gender; the p-value 0.740 indicates no statistically significant difference between men and women. Table 8 depicts the relationship between gender and cystic duct course; p-value 0.671, indicates no statistically significant difference between men and women. Figure 1 shows the relation between gender and the level of CD insertion, p-value 0.678, indicates no statistically significant difference between men and women.

Table 7: Relation between gender and site of cystic duct insertion

Site	Medial	Lateral	Posterior	Anterior	Absent	At confluence	At RHD	Total
Male	24	82	22	7	1	0	0	138
Female	28	98	32	11	0	1	1	171
Total	52	180	54	18	1	1	1	307
P value	0.740	Not significant						

Table 8: Correlation between the gender and course of cystic duct

Course	Spiral anterior	Spiral posterior	Parallel	Tortuous	Short CD	Spiral anterior then posterior	Total
Male	1	20	12	100	2	1	136
Female	0	28	19	122	2	0	171
Total	1	48	31	222	4	1	307
P value	0.671	Not significant					

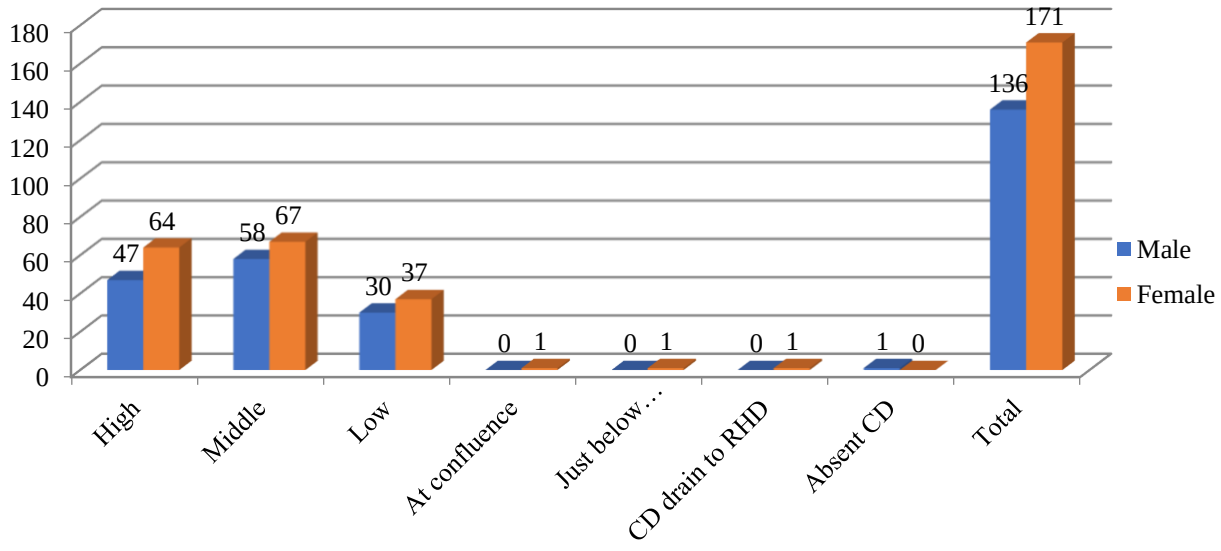

Figure 1: Correlation between the gender and the level of the cystic duct insertion

Discussion

Cystic duct variations have been indicated in the literature regarding its entire course, levels, and sites by joining the common hepatic duct with the cystic duct. In 58-75% of cases, the cystic ducts terminate at the middle third of the common hepatic duct from the lateral aspect (1). Ali Yasen et al., reported that 40.2% of cadavers in Sudan had middle insertions of the cystic duct (7). A study of 198 subjects in 51.5% of cases, the cystic duct had inserted in the middle third of the lateral aspect of the common hepatic duct (8). The result of this study displays 30.29% of the study group had typical anatomy of cystic duct, which was a low percentage in accordance with the above referred studies.

With regard to the cystic duct high level of insertion, Roccasalva et al., stated that only 5.3% of 582 patients had a high level of insertion (9), Tastemer identified 14.7% of 9307 patients had a high level of insertion (8), and Yasen reported it in 7.8% of cases (7). Pina et al., figured out 35.48% of the high cystic duct insertions (13), while Khayat discovered that in a 73.3 % of cases (10). This study revealed that a high insertion of the cystic duct was the most common variety which identified in 36.2% of the cases, this is a high percentage in contrast with the above listed studies, and the differences in the percentages explain the variability of the cystic duct anatomy. Low cystic duct insertion constitutes a 6.8% of the study group (11). Another study reported a 53.8% of data has low junction between the cystic duct and common hepatic duct (7). In 9% of cases there was low insertion (12). In comparability with finding of this study, the cystic duct was noted in 21.8% with low insertion, it was representing an elevated percentage.

Extreme variability is noted regarding the course of the CD. Yasen et al., reported long

parallel course of CHD and cystic duct in 13.8% of their study (7), Pina et al., reported 16.12% (13), in comparison to finding of this study, the parallel course was seen in 10.1% of cases. This variant was clinically significant if not recognized, the extrahepatic bile duct can be mistaken for the cystic duct, which can result in an unintentional section or ligation, and may lead to postoperative complications. If the long parallel cystic duct is ligated or transected too close to the CHD, the CHD can sustain strictures or narrowing at this site (2).

The spiral course of the cystic duct was reported by many studies, Roccasalva et al reported only 3.9% of cases had spiral course (9), Yasen found that spiral course in 9.2% of specimens (7), while Sarawagi et al., (14) and Shaw et al (15) reported high percentages of 38.3% and 32%, respectively, of spiral course. In comparison with previous studies of the cystic duct, this study result is in the middle of a wide range.

The cystic duct was discovered to be inserted medially in 10% to 18% of cases (16). Another study mentioned that 16% of cases had medial insertion (14), and Taourel et al., informed this variant in 17% of their subjects (12). In this study, 17.9% of cases had medial insertion, which is a close result in comparison with the previous mentioned study. This variant is important during surgery. Dissection of the medial cystic duct up to its end is considered dangerous, and it is advisable to leave a long remnant of the cystic duct (17). Rare variations in CD insertion are seen in the present study, and the percentage of these rare variations is close to that of most of the reported studies.

The presence of a short or absent cystic duct is a rare but important variant and increases the chance of biliary injury, especially during laparoscopic cholecystectomy operations (18), a short cystic duct of less than 5 mm was reported in 1.3-2.4% (1). In the current study it was seen in 1%, this variant had significant surgical importance, presence of short cystic duct may result in tenting of the CHD or CBD and inadvertent clamping of these ducts during the surgery (17). Aberrant drainage of cystic duct into right hepatic duct is rare and reported in 0.3 to 0.4% (19), in this study CD drain to the RHD in 0.3%. The CD in this study drain at the junction between the right and left hepatic duct, high insertion just below the junction of the right and left hepatic duct and RPHD drain to CD in 0.3% for each which are also near to Benson and Page which reported 0.7% for each (20), it is essential to diagnose the high union of the cystic duct, aberrant cystic duct drainage into the right hepatic duct and aberrant union of intrahepatic bile ducts to the cystic duct as these variants can be misdiagnosed during surgery leading to accidental transect and ligature.

Conclusion

The normal anatomy of the cystic duct is observed in only 30.29% of cases. Anatomical variations are encountered in 69.71% of cases, with high insertion of the cystic duct being the main variation observed in 36.2% of cases; the next most common variation is a low insertion in 21.8% of cases.

Conflict of Interests: None

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