Research Article

Analysis of anatomical variations of the Cystic Duct in Magnetic Resonance Cholangiopancreatography

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Abstract

Background and objectives- Anatomical variants of the cystic duct (CD) are important be identified and described in the radiological report. This facilitates proper interpretation of the pathological process related to the biliary tree. Also, prior information is important before surgical, percutaneous and endoscopic interventional procedures related to the biliary tree, to avoid inadvertent complications and for successful outcomes. Magnetic Resonance Cholangiopancreatography (MRCP)is the best non-invasive imaging modality in detecting anatomy of the non-dilated cystic duct.
This study was carried out to demonstrate imaging appearance of the cystic duct and its anatomical variants detected on MRCP and to document their prevalence in the study group.
Methods- This is a single centre retrospective cross-sectional study including all consecutive patients who underwent MRCP form May 2020 to May 2021 at the neurosurgical MRI unit at National Hospital of Sri Lanka. Patients who had undergone cholecystectomies and images with poor quality were excluded.
Results- Total 180 MRCP studies were analysed. Normally inserting CD to the lateral aspect of the Common Hepatic Duct (CHD) was observed in 127cases out of 180 (70.5%). 10(5.5%) demonstrated high inserting CD.12(6.6%) cases demonstrated low inserting CD.3(1.6%) had short CD. Parallel course of CD was noted in 12(6.6%). Low and medially inserting CD was present in 4(2.2%) cases. Anterior insertion was demonstrated in 5(2.7%) cases, and posterior insertion was demonstrated in 7(3.8%).
Conclusion- Anatomical variants of the CD observed in our study group were comparable to reported frequencies, however posterior insertion was lesser than that found in literature.

Keywords: Cystic duct, Anatomic Variation, Magnetic Resonance Imaging, Sri Lanka

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Introduction

Cystic duct connects the gall bladder to common hepatic duct. Anatomical variations of the cystic duct (CD) are often identified during imaging and reported in literature. It is important to be aware and report such variations in the radiological report as this facilitates proper interpretation of the pathological process related to the biliary tree. Prior information is also important before interventional procedures (surgical, percutaneous or endoscopic) related to the biliary tree to avoid inadvertent complications and for a successful outcome. [1,2]

The insertion point of the cystic duct to the extra hepatic biliary tree demarcates the division of common hepatic duct and the common bile duct. Approximate length of the cystic duct is 2-4cm and the diameter varies from 1-5mm.[1,2] Usual point of insertion of the cystic duct to the extra hepatic bile duct is midway between the porta hepatis and the ampulla of Vater. However, variations can occur during embryogenesis. The variations that occur in cystic duct could represent its number, length, course and point of insertion to the extra hepatic biliary tree. [2, 6,10]

MRCP is the best noninvasive imaging modality in detecting the anatomy of the non-dilated cystic duct compared to USS and CT without IV cholangiographic contrast media.[1,2,4] MRCP can provide coronal images with higher resolution, and angle of image acquisition oriented along the long axis of cystic duct provides best demonstration of the cystic duct. [2,4]

Although many studies have been carried out regarding the gall bladder and the biliary anatomy and related pathological processes, only few studies are focused on variations of the cystic duct anatomy. To our best knowledge currently no such studies are carried out in Sri Lanka. So, it is important to document their prevalence in our population. The National Hospital of Sri Lanka (NHSL), the main tertiary care center in Sri Lanka, providing care to people admitted from all over the country. The department of Dadiology and Diagnostic Imaging of NHSL plays a major role in diagnostic and image guided therapeutic procedures in patients with biliary disease.

This study was carried out to demonstrate the imaging appearances of cystic duct and its anatomical variants detected using consecutive MRCP studies that were performed during the study period at the neurosurgical MRI unit at the National Hospital of Sri Lanka and to document their prevalence in our patients.

Material and methods

A single center retrospective cross-sectional study was performed in the Neurosurgical MRI Unit, Department of Radiology, NHSL from May 2020 to May 2021. Study population included all consecutive patients who underwent MRCP for various indications, during the study period. Patients of both sexes were included. Patients who had undergone cholecystectomy were excluded. Images with poor quality, either due to patient factors or technical factors were excluded. The study instruments included, extracted data from MRCP and data collection sheets.

Data collection and analysis

The following definitions were used to document variations as mentioned in the literature.[2,4]

Normal insertion - CD joins the CHD at its middle third on its lateral aspect
High Insertion - CD joins the CHD at its upper third
Low Insertion - CD joins the CHD at its lower third
Lateral Insertion - Point of insertion is right of the CHD
Medial Insertion - Point of insertion is left of the CHD
Short CD - CD length < 5mm
Long parallel insertion - parallel course of CD with CBD for at least 2cm distance

All MRCP images in the console were assessed by two consultant radiologists. The number, course, length and point of insertion of CD into the Extrahepatic Biliary Ducts (EHBD) were documented. All the other variations in the intra hepatic and the extra hepatic bile ducts detected during the analysis were also documented. All the MRCP sequences were examined Maximum intensity projection sets of MRCP high resolution SENSE sequences images in coronal plane were particularly analyzed to document variations. To improve the reproducibility of the research an interobserver agreement was reached. The interobserver variation among the two raters was assessed by using kappa statistics.

Data was analyzed using the latest version of Statistical Package for Social Sciences (SPSS statistics 27) using standard descriptive statics.

Ethical Considerations

Ethical permission was obtained from the ethical review committee, Post Graduate Institution, Colombo. The institutional clearance was obtained from the Director, National Hospital of Colombo, Sri Lanka.

Results

A total of 180 MRCP studies were analyzed. 120 cases (67%) were male and 60 (33%) were female patients. The mean age was 46 years and age range 19-75 years. Results are summarized in Table 1.

Table 1: Distribution of different anatomical variations of the cystic duct and reported frequency in literature.

Type of cystic duct variations	Frequency (n=180)	Percentage (%)	Reported frequency in literature (%)
1. Normal lateral insertion	127	70.5	58-75
2. High insertion	10	5.5	5.5
3. Low insertion	12	6.6	9
4. Short CD	3	1.6	1
5. Parallel course of CD	12	6.6	7.5
6. Low medial insertion	4	2.2	4
7. Anterior insertion of CD	5	2.7	2
8. Posterior insertion of CD	7	3.8	20.2

Figure 1 shows the normally inserting CD to the lateral aspect of the CHD observed in a majority of 70.5% cases. Figure 2 illustrates a short cystic duct. The parallel course of the cystic duct with extrahepatic bile duct was observed in 6.6% frequency, shown in Figure 3. Anterior spiral insertion is demonstrated in Figure 4.

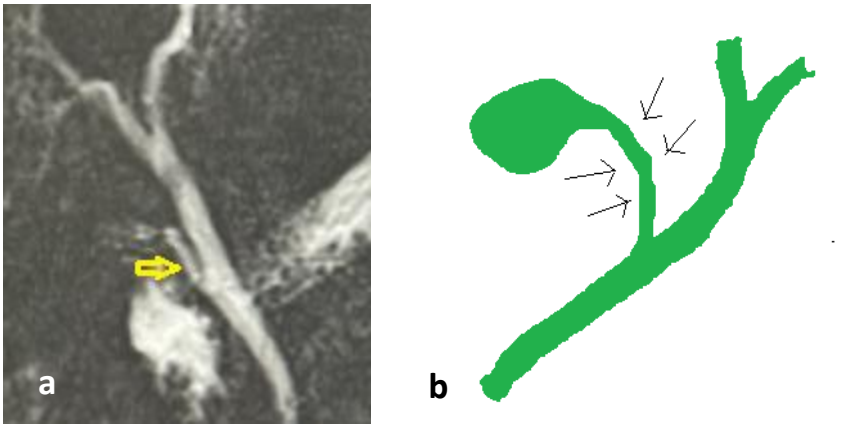

Figure 1: a) Coronal oblique MRCP shows normally inserting CD to the middle third of CHD from the lateral aspect (yellow arrow). b) Illustration of normal CD (black arrows) for comparison.

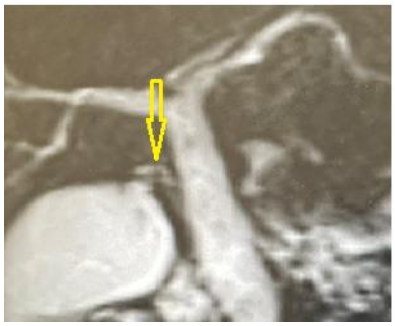

Figure 2: Coronal oblique MRCP shows short CD (arrow).

Figure 3: Coronal oblique MRCP shows parallel course of CD (arrow) with EHCD.

Figure 4: Coronal oblique MRI demonstrates anterior spiral insertion of the cystic duct (arrow).

Discussion

Cystic duct insertion to the extra hepatic bile duct midway between the porta hepatis and the ampulla of Vater is reported in 58%-75% cases in literature.[2] We have demonstrated this normal anatomy in 70.5% of our cases. Anatomical variations are important from surgical point of view, especially as there is a trend towards laparoscopic cholecystectomies in the recent era.[7] The risk of iatrogenic injury is high, where anatomy is misidentified before any interventional procedures.[8]

Prior information using noninvasive imaging is important before any interventional procedures for proper planning and to avoid complications. Also, for a successful outcome. One such important example includes problems arising during bile stone extraction with low and medially connecting cystic duct which frequently overlap with the distal CBD. During CBD cannulation at ERCP, inadvertent insertion of injection cannula, extraction balloon or basket into cystic duct can result in cystic duct injury or unsuccessful procedure if cystic duct cannulation is unrecognized.[1,3,5] Low inserting cystic duct was reported in 9% of cases in previous studies. 2. 6.6% of cases in our study showed cystic duct inserting in to lower third of the CHD. 2.2% cases demonstrated low and medially inserting cystic duct compared to the reported frequency of 4% in literature.[7] Increased incidence of CBD stones and recurrent CBD stones is a recognized sequalae of such low inserting cystic duct.[16,17]

Other clinically important variations include medially inserting cystic duct, parallel cystic duct to EHBD and short cystic duct.[1,2] In case of medially inserting cystic duct dissection up to its termination is considered serious and it is advised to leave a long remnant of cystic duct.

Short cystic duct demonstrated in 1.6% of our cases compared to 1% reported in literature.[7] There is a higher chance of CBD injury if this is not recognized prior to any surgical interventions.[9]

Parallel course of cystic duct with extrahepatic duct was demonstrated in 6.6% cases in our study and reported frequency is 7.5%. In some cases, cystic duct and common hepatic duct run a parallel course for at least 2cm and surrounded by a common fibrous sheath. During surgical interventions, if extrahepatic duct is mistakenly identified as

cystic duct, bile duct injury become inevitable.[2,3] In cases of medially inserting long parallel cystic duct, a long remnant of cystic duct is usually left after cholecystectomy. Inflammatory changes and calculus disease in this remnant cystic duct may result in post cholecystectomy syndrome.

We could not demonstrate any cases of double cystic duct, which is reported as a very rare variant in literature. Also, we didn't see any cases of aberrant cystic duct draining into the right hepatic duct which is reported in 0.3%-0.4% in literature.

The main limitation of our study is that we couldn't perform direct comparison of MRCP results with ERCP or intraoperative cholangiogram.

Conclusion

Anatomical variants of cystic duct observed in our study group were comparable to reported frequencies, however posterior insertion is lesser than that found in literature.

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