ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF RADIOLOGY

Title: prevalence and types of biliary and pancreatic duct anatomic variation in patient undergoing magnetic resonance cholangiopancreatography (MRCP) study in TASH, and diagnostic center in Addis Ababa Ethiopia: a retrospective study from February of 2022 up to February of 2025

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ADDIS ABABA, ETHIOPIA

DEPARTMENT OF RADIOLOGY

RESEARCH PROJECT SUBMISSION FORM

Name of investigator	Dr. Temis Gudeta, MD, 2nd Year Clinical Radiology Resident
Name of Advisors	1. Dr. Assefa K (MD, Consultant Radiologist and Body imaging subspecialist) 2. Dr. Semira A(MD, Consultant Radiologist and Body imaging fellow) 3. Dr. Aga (MD, Consultant Radiologist and Body imaging fellow)
Full title of the research project	Title: prevalence and types of biliary and pancreatic duct anatomic variation in patient undergoing magnetic resonance cholangiopancreatography (MRCP) study in TASH, Addis Ababa Ethiopia: a retrospective study from February of 2022 up to February of 2025
Duration of the project	September 30, 2024 to February 30, 2025
Study area	Tikur-Anbessa Specialized Hospital (TASH), and Private Diagnostic Center in Addis Ababa, Ethiopia
Total cost of the project	25,200 Ethiopian Birr
Source of budget	Research Fund from Addis Ababa University (AAU) and if any grant is available.
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ABBREVIATIONS

AAU-Addis Ababa University

CHD – common hepatic duct

CD - cystic duct

CBD – common bile duct

ERCP – endoscopic retrograde cholangiopancreatography

HP – hepatic duct

IOC – Intraoperative cholangiography

LHD – left hepatic duct

MRCP- magnetic resonance cholangiopancreatography

3D- MRCP – 3- dimensional magnetic resonance cholangiopancreatography

PD – pancreatic duct

PTC - percutaneous transhepatic cholangiography

RAHD – right anterior hepatic duct

RASD - Right anterior sectoral duct

RHD – right hepatic duct

RPHD – right posterior hepatic duct

RPSD - Right posterior sectoral duct

TASH- Tikur Anbessa Specialized Hospital

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Summary

Background

Knowing the normal branching pattern and anatomic variations of the pancreatic and biliary duct is extremity important for both radiologist and hepatobiliary surgeons. This anatomic variations may have no significant clinical importance per se but has important clinical implication in hepatobiliary surgery, endoscopic and image guided intervention. Knowing branching pattern of biliary duct help radiologist in deciding best approach in obstructed biliary duct intervention. Knowing the cystic duct anatomic variation preoperatively makes laparoscopic surgeon not to cause iatrogenic biliary duct injury. Liver resection surgery is also currently increasingly done for focal liver disease and knowing the biliary drainage system avoid complication including biliary cirrhosis or biliary leak. Finally knowledge of this anatomic variant has important clinical implication in selecting potential living liver donors for successful harvesting and to minimize post op complication (even if liver transplant not yet started in our setup).

MRCP study is the least invasive and one of the most reliable imaging modality for evaluation of biliary and pancreatic duct. Currently, there is no study done on the prevalence and types of anatomic branching variation of the pancreatico-biliary duct in Ethiopia using MRCP or other imaging modalities.

Objectives

To study the prevalence and types of the anatomic branching variations of pancreatico-biliary duct in Ethiopia using MRCP at TASH and private diagnostic center, Addis Ababa, Ethiopia.

Methodology

A retrospective cross-sectional study will be conducted at TASH and selected private diagnostic center in Addis Ababa. The study will be conducted on patients who had undergone MRCP study for clinically suspected biliary and pancreatic pathology from October 2022 to October 2025. A structured research tool will be used to collect all the necessary data from participants and MRCP study will be evaluated by the investigator

with from expert radiologist with experience in the field. Participant will be selected by selected by simple random sampling method. Data will be entered and analyzed using SPSS version 28 software.

Work plan and budget

The working budget will be covered by Addis Ababa University, College of Health Sciences, and School of Graduate Studies. The study period will be from September 30, 2025 to February 30, 2025. The total estimated cost of the study is 25200.00 ETB.

1. INTRODUCTION

1.1. Background

Knowing the typical and variant anatomy is necessary for radiologist. Knowledge of the anatomic variation is especially important in areas like hepatobiliary system where there is high rates of anatomic variation and has important clinical implications. Many anatomical studies have been conducted in order to determine the specific anatomical variations, using cadaveric material, intra-operative data, or imaging such as ultrasonography and MRCP. Direct cholangiography methods [percutaneous transhepatic cholangiography (PTC) and endoscopic retrograde cholangiopancreatography (ERCP)] or indirect cholangiography methods (transabdominal ultrasonography, CT cholangiography and MRCP) may be used to obtain images of the biliary ducts. Because MR cholangiography is becoming the modality of choice for noninvasive evaluation of abnormalities of the biliary tract (requiring neither the use of contrast medium injection nor any biliary intervention, also adding other sequence enable to assess beyond duct) and because surgical procedures such as liver resections and partial liver transplantations are increasing in frequency and complexity, a more widespread understanding of biliary anatomy and potential variations is needed.(1), (2), (9)

MR cholangiopancreatography is a magnetic resonance imaging (MRI) technique using T2-weighted sequences to evaluate the anatomy and pathologies of the pancreatobiliary system. Using heavily T2 weighted sequences, MRCP techniques accentuates signal intensity of static or slowly moving particles, resulting in increased duct-to-background contrast. As compared to other means MRCP is noninvasive, radiation free, and no need of contrast injection with rapid and reliable depiction of biliary and pancreatic structure.(2)

Couinaud described eight distinct hepatic segments. Each of this segments have their own portal venous supply and hepatic venous drainage system. Intrahepatic biliary duct anatomy is coincident with liver segmental anatomy according to the Couinaud classification. The biliary drainage system and the portal venous in general have parallel course. Right hepatic lobe is drained by the right hepatic duct (RHD) with right posterior branch draining the posterior segment VI and VII and anterior branch draining the anterior segment V and VIII. The posterior branch with more horizontal course, pass behind the anterior branch which has more vertical course and joins the right anterior duct from medial the medial side to form the right hepatic

duct. The left hepatic duct (LHD) is formed by branches that drain the left hepatic lobe; medial and lateral segment (segments II–IV). The RHD which commonly shorter than the LHD join together to form the common hepatic duct at porta hepatis. The caudate lobe usually drains separately and joins at the confluence of the left and right hepatic duct. (3) (10)

The cystic duct arising from the gall bladder and joins the common hepatic duct to form the common bile duct. Classically CD ranges 2-4 cm in length and 1 -5mm in diameter and inserts at the middle third of the CHD from the lateral aspect between hepatic duct confluence and ampulla of Vatur. The CD also shows different anatomic variations icluding insertion at distalthird, having parallel course with CBD, insertion on the medial side of CBD, shortor abscent CD and drainage to RHD, or LHD.

However, as demonstrated in different studies, there is great variability in the anatomy of the hepatic biliary tree, gallbladder, and pancreatic ducts, since biliary tract structure shows racial and ethnic variation. This typical biliary anatomy is reported to range between 58 and 68 % of cases. These variants generally do not have clinical significance but can increase the probability of an iatrogenic injury due to inadvertent ligation or transection during interventional procedures

Identifying the anatomical variations of the bile ducts preoperatively can help in the planning of surgical intervention and the prevention of complications associated with iatrogenic injuries. There are several classifications for these anatomical variants, some of which include Nakamura, Couinaud, Choi, Varotti, and Ohkubo, which classify the most variants, and Bageacu, Yoshida, Lee, Puente, Cho, Cucchetti, and Huang, which are the most commonly used in the literature related to imaging. (4)

For intrahepatic bile duct to be labeled typical the following branching pattern should be full filled. Horizontally running RPD joins to the vertically coursing RAD in the medial aspect to form the common duct, the right hepatic duct. Then the right duct joins the left hepatic duct to form the common hepatic duct (CHD). Any deviation from the above description was considered as anatomic variation. The following three tables shows the Sureka, et al Bile duct variations classification systems.(5)

The pancreas develops from ventral and dorsal pancreatic buds arising from the caudal part of the foregut**.** The dorsal bud forms the head, body and tail, while the ventral bud develops into the uncinate process. In majority of individuals, the union of these structures allows for a fusion of their ductal systems such that the main pancreatic duct (MPD) serves as the path for emptying of pancreatic secretions into the duodenum via the major duodenal papilla. A normal anatomy of pancreatic duct was considered when the main pancreatic duct is divided into two ducts, the duct of Wirsung, which is posterior and drains the ventral pancreas in the major papilla together with common bile duct and this common channel named pncreaticobiliary junctionis intramural and measures 10-15mm. The accessory duct of Santorini, which is anterior and drains the dorsal pancreas in minor papilla. (14), (6, 7).

Anatomic variation of pancreatic duct is also common and may be associated with recurrent pancreatitis. Most common anatomical variants of the pancreatic duct is pancreas divisum which results from non-fusions of dorsal and ventral pancreatic duct. The other anatomic variant included ansa pancreatica, Anomalous pancreaticobiliary ductal junction. (22)

Statement of the Problem

Knowing anatomic variations of the biliary and pancreatic duct has major clinical importance in a away it affect diagnostic and therapeutic procedures of biliary pathologies, liver resection surgeries and cholecystectomy in addition to being risk factors for some hepatopancreatic disorder. In spite of the clinical relevance of these anatomic variations and Magnetic Resonance Cholangiopancreatography (MRCP) providing a non-invasive means of identifying such variations, yet research done on prevalence of this anatomic variations are lacking in Ethiopian populations. A better understanding of prevalence and types of this anatomic variations and incorporating in our radiology report could improve diagnostic accuracy and patient outcomes, reduce iatrogenic complications during surgeries, and assist in the development of guidelines for clinical practice.

1.2 Significance of the study

Given that anatomical variations are common and can influence patient outcomes, understanding these patterns in the local population is vital for improving healthcare delivery. The significance

of conducting this study stems from lack of localized data on biliary, and pancreatic duct variations. So local data is important as Ethiopian population may have unique anatomical characteristics that differ from those in other populations (study also show the incidence of biliary duct variations depends on various factors, including country, region and race). This study aims to fill this knowledge gap by investigating the prevalence and types of anatomic variations in these ducts in patients undergoing MRCP in Ethiopia. This study also serve as baseline data for future research in the country, thereby contributing to the national and global body of knowledge on biliary and pancreatic ductal variations.

2. LITERATURE REVIEW

Prevalence of anatomic variations of the biliary duct and geographic variation

Available data suggest that anatomic variants seem to show geographic variation being more frequent in Asiatics population. A European meta-analytical study involving 22 reports and 7559 cases with reports from Europe accounted for 794 cases (10.5%), from America for 4,146 cases (54.8%), and from Asia for 2,619 cases (34.6%) demonstrated prevalence of typical biliary anatomy to be 60% in European and Americans and with slightly higher prevalence in Asiatics of 65%. The total number of typical anatomy cases reported was 4,598 (60.8%) and total biliary anatomic variants were 2,961 (39.2%); in particular, trifurcation was described in 904 cases (11.9%) and an abnormal right configuration in 1,324 cases (17.5%). (8)

An MRCP study done by Shamir O Cawich et al in 2009 on 152 Carribean patients 86 males and 66 females found 109 (71.7%) persons with “classic” biliary anatomy (type A1) and variants were present in 43 (28.3%) persons. They found a greater incidence of Huang A2 trifurcations and a lower incidence of Huang A3 variants and no statistical relationship between the presence of anatomic variants and gender or ethnicity were found. (9)

Prevalence of anatomic variations of the biliary duct and gender variation

Available data also suggest that anatomic variants seem to be more frequent in females, probably as a consequence of different embryologic development. A study done in Turkey with one of largest sample size of 1041 found typical anatomy in 57.2 % of the females and 62.1 % males. Anatomic variation of the biliary tree was present in 40.7 % of the study populations (42.8 % of

the female patients and 37.91 % of the male) and, of this 1.15 % had two anatomical variations. Trifurcation variation at the level of bifurcation and medial insertion of cystic duct at the level of cystic duct insertion were variation with the highest incidence 12.8 and 5.37% respectively. Another study in Aegean region of Turkey with sample size 1011 found typical anatomy in 79.4% of the study population. This study also shows that females present more frequently with anatomic variant (with typical anatomy in females was 75.7% as compared to 85.3% in males). Trifurcation and aberrant right hepatic duct emptying in to common hepatic duct was the two most common anatomic variation in this study. (10), (11)

Anatomic variants of the pancreatic duct

A large systematic review involving 8200 patients found that 94.3% of the study subjects had normal pancreatic duct anatomy where as 5.7% had variant anatomy. Pancreatic divisum were the most common anatomic variation which occur in 4.5% of cases. The remaining 1.25% had other variant including ansa pancreatica in 0.25 %.(21)

A population based study done in Germany using secretin stimulated magnetic resonance cholangiopancreatography (MRCP) to determine the anatomic variants of the pancreatic duct and their clinical relevance, found that 93.2 % of the study were of diagnostic quality. Normal PD variants were observed in 90.4 %. Variants of pancreas divisum were identified in 9.6. In this study there was no association between pancreatic divisum and morphological signs of chronic pancreatitis. (14)

MRCP vs other diagnostic methods

A prospective descriptive comparative study in Egypt in 50 subjects between ERCP and MRCP found that both methods are comparable in depicting biliary anatomical variant with differences in two cases (4%). Complication developed in 4(8%) of the participant of which acute pancreatitis and bleeding in 1 cases. (20)

A study comparing three-dimensional Magnetic Resonance Cholangiography (3D MRCP) with intraoperative cholangiography (IOC) in 20 right hepatic liver lobe donors show that 3D-MRCP were accurate in predicting biliary anatomy in 18 out of 20 donors with specificity and positive predictive value of defining normal anatomy of 100%. In 2 patients, 3D MRCP failed to identify

abnormal anatomy. The angle of the biliary confluence as well as the length of the duct increased the accuracy and value of 3-D MRCP in predicting biliary anatomy.(12)

A similar study done in Egypt with total subject of 120(24 potential liver donors and 96 volunteers) with subsequent bile duct exploration or intraoperative cholangiograms for the 23 subjects. In 22 of the subjects the MRCP and intraoperative classification were the same with only one case (4.35%) was considered as trifurcation at MRC but the intraoperative classification was RPHD inserted to LHD, which was attributed to distal insertion of RPHD to end of LHD. In this study they also found 65.8% have typical branching pattern where as 34.2% has variant anatomy. The variant were as follow: trifurcation in 11.67% (n = 14); RPHD to LHD, in 13.3% (n = 16); RPHD to MHD in 7.5% (n = 9); and RPHD to cystic duct in 1.67% (n = 2).(13)

3. OBJECTIVE

3.1 General objective

To assess the pancreatic and biliary duct branching pattern using MRCP in patient visiting TASH and diagnostic center in Addis Ababa, and Ethiopia between February 20222 and February 2025.

3.2 Specific objectives

To determine pancreatic and biliary duct branching pattern

To compare the local branching pattern with the current reference value stated in the literature.

To identify how the pancreatic and bile duct branching pattern related with patient sex, age and presentation

To determine the indications for magnetic resonance cholangiopancreatography examination

To determine diagnostic yield of MRCP in depicting pancreatic biliary duct

4. METHODS AND MATERIALS

4.1 Study area and period

The study will be conducted at Tikur Anbessa Specialized Hospital (TASH) and private diagnostic center in Addis Ababa. TASH is a largest referral and teaching hospital, under the administration of Addis Ababa University, where hepatobiliary subspecialty care is available. Many patients with

hepatobiliary and pancreatic pathology are referred to this hospital. As currently no MRI imaging services is available at TASH majority of MRCP study is done at private diagnostic center. So the MRCP study done at this private diagnostic center for patients referred from TASH will be used. The study will be conducted between October 2024 and February 2025

4.2. Study design

A retrospective cross sectional study design will be employed and the investigator with guidance of senior radiologist with experience in MRCP reading will assess the MRCP scan for the biliary and pancreatic duct branching pattern.

4.3. Source and study population

All patients who visits TASH and had MRCP study done between February 2022 and February 2025 the will serve as the source population and the study population will be those who fulfilled the inclusion criteria.

4.4. Eligibility criteria

Inclusion criteria

All patients who have MRCP study will be included in the study.

Exclusion criteria

Patient with suboptimal imaging and technical reasons (poor imaging quality and image degradation due to motion artifact), with history of biliary and liver resections surgery, pancreatic tumors grossly distorting visualization of duct, inadequate biliary tract depiction and abnormalities of the hilar segmental bile ducts resulting in difficulty to characterize the biliary patterns will be excluded from the study

4.5. Sampling procedure and sample size

The sample size is calculated using a single population proportion formula.

$$n = \frac{(Z - score)^2 \times StdDev \times (1 - StdDev)}{confidence\ interval^2}$$

Assumptions; n is the required sample size, Z- critical value for normal distribution at 95% confidence level (1.96), confidence interval- 0.05 (5% margin of error), a standard deviation of 0.5, and 5% of non-response rate is added. Therefore, based on the aforementioned assumptions,

385 participants will be enrolled in this study. All eligible patient will be included until the sample size is reached; using a random sampling approach.

4.6. Study variables

4.6.1. Dependent variable

Prevalence and types of anatomic variant of biliary duct, cystic duct ad pancreatic duct detected by MRCP

4.6.2. Independent Variables

Sociodemographic factors

- Age
- Sex
- ?Residence
- ?Religion
- ?Ethnicity

Clinical factors

- Patient clinical symptoms
- Presumptive clinical diagnosis
- Indications for MRCP
- Past hepatobilliary and pancreatic intervention

4.7.Data collection and measurements

All MRCP study obtained using 1.5 or 3T magnetic resonance system will be used. The MRCP study done between February 2022 and 2025 for those patient referred from TASH will be extracted from the archive of the imaging center. The image will be evaluated by the researcher with guidance from the senior radiologist with specialty in body imaging. The intrahepatic and extra hepatic biliary duct and pancreatic duct will be evaluated for the branching pattern. If there is atypical branching pattern the types will be described as per study done by Sureka et al for the biliary and cystic duct. The Sureka et al. classify both right and left intrahepatic duct as well as cystic duct more extensively and is also convenient. The pancreatic duct will also be assessed for configuration variations, course variations, Duplication anomalies, anomalous pancreaticobiliary ductal junction (APBU). The

full anatomic variant of the intra and extra hepatic biliary duct and pancreatic duct are described in table form at the annex part.

Demographic variables such as age, gender, ethnicity, religion, place of residence, and clinical factors including clinical presentation, presumptive clinical diagnosis, history of past hepatic and pancreatic intervention, will be extracted from the patients' electronic medical records (Specifically the institutions database of IWKET care) by using a data collection tool.

4.8 Data processing

4.8.1 Data handling

The collected data will be entered, cleaned, stored, and checked for completeness and internal consistency.

4.8.2 Data processing and analysis

Data will be coded and entered into a computer by using SPSS for analysis. The result of the study will be presented by tables and charts.

4.9.Data Quality Control and Measurement

Patient data and measurements will be checked for completeness by data collectors and supervisors daily. Furthermore, re-checking will be done before data entry.

4.10. Ethical Consideration

Ethical clearance and official letter from Addis Ababa University, College of Health Sciences, and School of Medicine will be sought. The selected private diagnostic center will receive an official letter and permission will also be sought from the above-mentioned areas in order to undertake the research. Confidentiality will be maintained by keeping information anonymous and ensuring that it will not be available to anybody other than researcher.

4.11 Dissemination of the Results

Addis Ababa University, School of Medicine and the Department of Radiology will receive my results of the research study. In addition, the research findings will be presented in a seminar presentation and if possible, published in a peer-reviewed journal. Publication will also be used to communicate the findings.

4.12 Limitation of the study

The main limitation of study is that the source population are patients who undergone MRCP with suspicion of biliary or pancreatic disease and this population may not sample the population. The other limitation will be lack of reference standard to compare with like cholangiography or surgery. This study is also limited by its reliance on retrospective data collection and may not capture all relevant information.

5. WORK PLAN AND BUDGET

5.1 work plan

Table 1 – work plan

S. No	Activities	Time (September 1, 2024 - February 30, 2025)		
		September 1, - October 30, 2024	November 1 – December 30, 2024	January 1- February 30, 2025
1	Topic selection			
2	Developing Proposal			
3	Proposal review and edition			
4	Submission of the final draft and approval			
5	Obtaining a letter of support from AAU			
6	data collection			
7	Data entry and cleaning			
8	Data analysis and write up			
9	Submission of final research paper and defending			

5.2 Budget

Table 1 – Budget breakdown

S/No	Budget category	Type/Detail	Unit price	Multiplying factor	Total cost (Birr)
1	Stationary materials for the research purpose	Notebooks	80	5	400birr
		Pens	30	20	600birr
		Hard disc	10000	01	10000birr
2	Service	Internet fee	1200/month	6months	7200birr
		Mobile Card	100/month	6months	600birr
		Printing Cost	20birr/page	100page	2000birr
		Transportation Cost	-	-	3000
3	Manpower cost	Data analysis	5000	1	5000
	GRAND TOTAL	**GRAND TOTAL**	**GRAND TOTAL**	**GRAND TOTAL**	**28,800**

DATA COLLECTION TOOL

Prevalence and types of biliary and pancreatic duct anatomic variation in patient undergoing magnetic resonance cholangiopancreatography (MRCP) study in TASH, Addis Ababa Ethiopia

I. Socio-demographic information of the patient

1. Patient ID _____
2. Age: _____
3. Sex: A. Male B. Female
4. Residence
5. Religions

II. Relevent medical history

1. Patient clinical presentation
2. History of biliary or pancreatic surgery
3. History of pancreatitis, gall stones, jaundice

Table 1: Branching patterns of right hepatic bile duct	
Layout (type)	Interpretation
Type I	Typical: RPSD joining RASD medially to form RHD
Type II	Trifurcation: Simultaneous emptying of the RASD, RPSD, and LHD into the CHD
Type III	Anomalous drainage of RPSD A- RPSD joining LHD (crossover anomaly) B- RPSD joining CHD C- RPSD joining cystic duct
Type IV	Aberrant drainage of RHD into the cystic duct
Type V	Accessory right hepatic duct
Type VI	Segments II and III duct draining individually into the RHD or CHD
Type VII	Others and unclassified variations
RPSD: Right posterior sectoral duct, RASD: Right anterior sectoral duct, RHD: Right hepatic duct, LHD: Left hepatic duct, CHD: Common hepatic duct	

Table 2: Branching patterns of left hepatic bile duct	
Layout (type)	Interpretation
Type A	Common trunk of segment II and segment III joins segment IV
Type B	Triconfluence of segments II, III, and IV
Type C	Segment II duct drains into common trunk of segment III and segment IV
Type D	Others and unclassified variations

Table 3: Branching patterns of the cystic duct	
Layout (type)	Interpretation
Type A	Long cystic duct with low insertion into the distal third of CBD
Type B	Medial cystic duct insertion
Type C	Parallel course of cystic duct with common hepatic duct
Type D	Abnormally high fusion of cystic duct with common hepatic duct

Type E	Cystic duct entering the right hepatic duct
Type F	Cholecystohepatic duct or subvesical duct
Type G	Cystic malformation of cystic duct
Type H	Others and unclassified variation
CBD: Common bile duct	

Anatomic variations and anomalies of the pancreatic duct system	
Type	subtypes
configuration variations	bifid configuration with dominant main pancreatic duct MPD, dominant accessory pancreatic duct (APD) without divisum pancreas divisum, absent APD ansa pancreatica cystic dilations of terminal portions of the MPD and APD
course variations	descending, loopshaped or ring-shaped, vertical, and sigmoid
Duplication anomalies	
anomalous pancreaticobiliary ductal junction (APBU)	PD and CBD fusion outside the duodenal wall, with a long common channel (> 15 mm)

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