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Variations in Pancreatic Duct Course, Configuration and Pancreaticobiliary Junction on MRCP in 3-T MRI: A Descriptive Cross Sectional Study

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ABSTRACT

Introduction

Anomalies and anatomic variations of the pancreatic duct must be identified because they can predispose to conditions like pancreatitis, choledochal cysts, and cholangiocarcinoma, as well as increase surgical complications. In this study, we describe the course and configuration of pancreatic ducts and pancreaticobiliary confluence in cholangiopancreaticography on 3-Tesla magnetic resonance (3-T MR) scanner.

Methods

This cross-sectional descriptive study was done after obtaining ethical clearance, and included 128 magnetic resonance cholangiopancreatography (MRCP). The MRCP image records from December 2015 to 2018 were retrospectively analyzed for pancreatic duct course, configuration, angle of pancreaticobiliary confluence and common channel. Obtained data was entered in previously prepared proforma. Statistical analysis was performed using SPSS v 16.

Results

There were 56 (43.8%) males and 72 (56.2 %) females with mean age 48.72±18.05 years, ranging from 3 - 84 years. The most common pancreatic duct course was descending in 45 (36.3%) followed by sigmoid in 42 (33.9%) and vertical in remaining 37 (29.8%) patients. The most common ductal configuration was rudimentary non-dominant duct of Santorini in 88 (71%) patients followed by bifid configuration with dominant duct of Wirsung in 27 patients (21.8%). Pancreatico-biliary junction was more often acute angled than right or obtuse. The common indications for undergoing MRCP were pain abdomen (102, 82.8%), vomiting (53, 43%) and jaundice (36, 28.9%).

Conclusion

In symptomatic patients undergoing MRCP, the common anomalies of the pancreatic duct observed were descending course, rudimentary non-dominant duct of Santorini configuration and acute pancreatico-biliary angle.

Keywords
Duct of Santorini; duct of Wirsung; magnetic resonance imaging; pancreatic ducts

INTRODUCTION

Pancreas and pancreatic ducts have complex embryological development and associated congenital anomalies and anatomic variants like pancreas divisum, annular pancreas, agenesis of pancreas or hypoplasia of the dorsal pancreas, variations in the course/ configuration of the main pancreatic duct, anomalies related to duplication, and pancreaticobiliary ductal anomalous junction.[1] Though usually seen incidentally, identification of such variants is clinically significant like in unexplained recurrent pancreatitis, gastric outlet obstruction, predisposition to choledochal cyst, cholangiocarcinoma and gall bladder carcinoma.[2]

Magnetic resonance cholangiopancreatography (MRCP) is preferred over endoscopic retrograde cholangiopancreatography (ERCP) due to the non-invasiveness, ease, reliability and safety concerns. Dynamic, secretin stimulated MRCP can further enhance the visualization of pancreatic ducts and when combined with other routine sequences, extraductal evaluation can also be done.[3] Medical literature on variations in pancreatic duct and pancreaticobiliary confluence is scarce with data particularly lacking in our population. The aim of our study was to assess frequency of variations in pancreatic duct course, configuration and pancreaticobiliary confluence in MRCP using a 3-Tesla (3-T) machine.

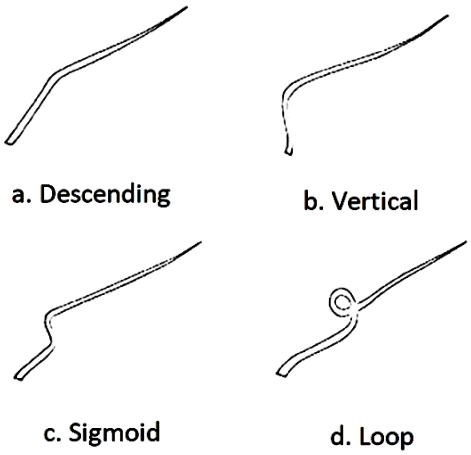

Figure 1. Schematic diagram showing variations in course of pancreatic duct

METHODS

After the ethical approval was obtained from Institutional Review Committee of Institute of Medicine (291(6-11-E)²/074/075) with waiver of patient consent, retrospective analysis of MRCP done between December 2015 and December 2018 in a 3T MRI scanner for various indications at Jeebanta Advanced Kathmandu Imaging, of Kathmandu was done.

Sample size was obtained using the formula: $n=Z^2\times(p\times q)/e^2 =(1.96)^2x0.18x(1-0.18)/(0.07)^2 = 115$, where, n= required sample size, p=18%, taken from previous study Liessi et al, where variations including pancreas divisum, bifid configuration, loop, ansa pancreatica and other rare variants were seen in18% cases,[4] q=1-p, d= margin of error, 7%, Z=1.96 at 95% Confidence Interval. Convenient sampling method was used. Patients with previous pancreatico-biliary surgery, ascites or motion artefact distorting the ductal anatomy on MRCP were excluded.

MRCP was performed using a 3-T MR scanner machine with a sixteen-element quadrature phased array body coil over the liver following standard protocol. Respiratory triggered T2 SPAIR axial and T2 coronal sequence with slice thickness 5mm including liver and pancreatic region were obtained. 2D and 3D MRCP images using breath-hold thick-slab heavily T2-weighted fat saturated singleshot fast spin-echo images centered at CBD covering entire pancreatico-hepaticobiliary system were also obtained. Images available in the workstation were reviewed by two radiologists with more than 7 years of experience. Maximum Intensity Projection (MIP) reformats and thin collimation axial and coronal source images were evaluated for visualization of the pancreatico-biliary ducts.

Variations in pancreatic duct course, configuration, angle of pancreaticobiliary confluence and presence of common channel were visually assessed. Pancreatic duct course was categorized as shown in the schematic diagram into four categories (Figure 1). Likewise, the duct configuration was classified according into six types as shown in figure 2 based on classification by Adibelli ZH et al.[5] We included a sixth type where both ducts of Wirsung

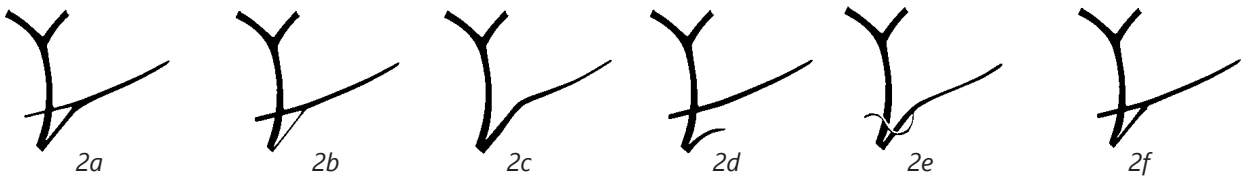

Figure 2. Schematic diagram showing variations in configuration of pancreatic duct. 2a. Bifid configuration with dominant duct of Wirsung drainage. 2b. Bifid configuration with dominant duct of Santorini drainage. 2c. Rudimentary non-draining duct of Santorini. 2d. Pancreatic divisum. 2e. Ansa pancreatica. 2f. Bifid configuration with symmetrical duct of Wirsung and Santorini of equal caliber

and Santorini were co-dominant. The pancreatico-biliary confluence was evaluated for the length of common channel when present and the angle of the confluence. The common channel was grouped by its length into <5 mm, 5-10 mm, 10-15 mm and >15 mm.

Data was tabulated in excel. Simple statistical tests were used for describing the findings as frequencies with percentages. Means and standard deviations were used to represent the numerical data. Statistical analysis was applied using the IBM SPSS v16 .0.

Table 1. Frequency distribution of the course of pancreatic duct

Course	Total n (%)	Males n (%)	Females n (%)
Descending	45 (36.3)	24 (45.3)	21 (45.3)
Vertical	37 (29.8)	16 (30.2)	21 (29.6)
Sigmoid	42 (33.9)	13 (24.5)	29 (40.8)
Loop	0	0	0
Total	124 (100)	53 (100)	71 (100)

RESULTS

MRCPs of total 128 patients were included in the study, among which 56 were males (43.8 %) and 72 were females (56.2 %). The mean age of the patient was 48.72±18.05 years with median being 48 and range varying from 3 – 84 years. The common presenting complaints were pain abdomen (82.8%), vomiting (43%) and jaundice (28.9%). Other symptoms included loss of appetite (20.3%), itching (13.3%), fever (10.2%) and weight loss (1.6%). Most of the MRCP studies were normal (30, 23.4%), followed by cholelithiasis with or without choledocholithasis (51, 39.8%), acute or chronic pancreatitis (17, 13.3%) and cholecystitis (7, 5.5%). The other findings included choledochal cyst, pancreatic divisum, primary sclerosing cholangitis, hepaticolithiasis, and malignancies including four cases of gall bladder carcinoma, three hilar and one distal cholangiocarcinoma.

Among MRCPs of 128 patients, four were excluded from the study due to inadequate visualization of the pancreatic duct due to pathological and technical factors. Of the remaining 124 patients, the most common type of ductal course was descending type seen in 45 patients (36.3%) while loop course was not seen in our study (Table 1).

The most common ductal configuration was rudimentary/ non draining duct of Santorini observed in 88 patients (71%), followed by bifid configuration with dominant duct of Wirsung seen in 27 patients (21.8%), bifid configuration with dominant duct of Santorini in 5 patients (4%) and bifid configuration with symmetrical duct of Wirsung and Santorini of equal caliber in 2 patients (1.6%). One patient (0.8%) each was found to have pancreatic divisum and ansa pancreatica configuration of pancreatic duct. The course and configuration of pancreatic duct was cross-tabulated with gender which showed that the most common course was descending in males and sigmoid in females. However, the most common configuration was rudimentary/no draining duct of Santorini in both sexes (table 2). Pearson chi square test revealed no statistically significant correlation between gender and course ($p = 0.11$) or configuration of pancreatic duct ($p = 0.38$).

Common channel was present in 108 patients (87.1%) while pancreatico-biliary confluence was not visualized in 16 patients. The angle of pancreaticobiliary confluence was divided into right or obtuse angle and acute angle (<90°). Acute angle was more commonly observed (n= 86, 69.4%) than right or obtuse angle (n= 22, 17.7%). Most patients (n= 94, 75.8%) had common channel measuring <5 mm, whereas none of the patients had common channel measuring >15mm in our study (Figure 3).

Table 2. Frequency distribution of the configuration of pancreatic duct

Configuration	Total n (%)	Males n (%)	Females n (%)
Bifid configuration with dominant duct of Wirsung drainage	27 (21.8)	10 (18.9)	17 (23.9)
Bifid configuration with dominant duct of Santorini drainage	5 (4)	4 (7.5)	1 (1.4)
Rudimentary / Non draining duct of Santorini	88 (71.0)	37 (69.8)	51 (71.8)
Pancreatic divisum	1 (0.8)	0 (0)	1 (1.4)
Ansa pancreatica	1 (0.8)	1 (1.9)	0
Bifid configuration with symmetrical duct of Wirsung and Santorini of equal caliber	2 (1.6)	1 (1.9)	1 (1.4)
Total	124 (100)	53 (100)	71 (100)

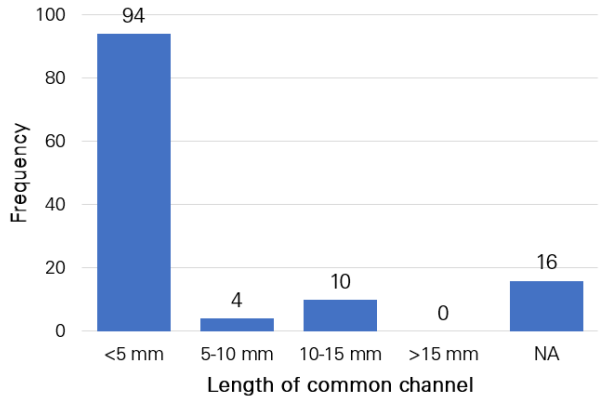

Figure 3. Frequency distribution of the length of the common channel

DISCUSSION

Recent developments in diagnostic imaging have resulted in a greater understanding of anatomic variants in the pancreas and pancreatic duct that may be clinically important and treatable.[6] These may predispose to certain conditions like pancreatitis, choledochal cysts etc and cause chronic abdominal pain, nausea and vomiting of no specific cause. Evaluation of pancreatic ductal anatomy is recommended in such patients.[1] MRCP is an excellent modality for evaluating biliary and pancreatic ductal anatomy, variations and pathology.[3] Except for pancreas divisum, other variations have received little attention. While most studies highlight clinical significance of the pancreatic ductal variations, study by Bulow et al. showed no relation between exocrine function of pancreas and anatomic variants and suggested limited clinical relevance of the same.[2] The pancreatic duct was analyzed in our study in terms of its course, configuration, and pancreatico-biliary confluence.

There are two ductal system drainage for pancreatic secretion: Main pancreatic duct (Duct of Wirsung, which develops from ventral and distal portion of dorsal pancreatic duct) and accessory pancreatic duct (Duct of Santorini). The main pancreatic duct enters the duodenum along with common bile duct at the major papilla. The proximal portion of the dorsal pancreatic duct mostly disappears or may sometimes persist as the small accessory duct (Duct of Santorini) which drains into the minor papilla, located 2 to 3 cm proximal to the ampulla of Vater.[6] Pancreatic divisum may occur when dorsal and ventral pancreatic buds fail to fuse along with the ductal system and may predispose to pancreatitis.[7] Rest of the pancreatic duct variants are not well studied.

Common channel measures normally between 1-12mm (mean 4-5 mm). This is considered abnormal when > 4mm in infants and > 6mm in adults.[8] Anomalous pancreaticobiliary ductal (APBD) junction results when fusion of the pancreatic duct and common biliary duct occurs outside the duodenal wall and there is formation of a long common channel usually longer than 15 mm, predisposing to choledochocele, cholangiocarcinoma or gallbladder carcinoma, or choledocholithiasis.[9] The frequency is reported as 1.5-3.2 %, though we did not find any APBD junction in our study, which may be due to the limited sample size.[10,11]

The course and configuration of pancreatic duct varies in different population. We found descending (36.3%) course of pancreatic duct was most common followed by sigmoid (33.9%) and remaining vertical (29.8%) with no loop course (table 1). This is consistent with the findings in Palestinian population where descending course was seen in 75.4%, sigmoid in18.7%, vertical in 4.4% and loop in 1.2%.[12] Adibelli ZH et al. also found descending type was the most common course (62.59%) followed by sigmoid (30%), vertical (5.5%) and loop (2%).[5] We did not find any case of meandering main pancreatic duct which includes loop and reverse-Z type of pancreatic course. This was seen in 2.2% of general population and found to be statistically significantly associated with idiopathic recurrent pancreatitis, in a study by Gonoi et al.[13] Although the frequency of course in our study was similar to other studies, the percentage was significantly lower for descending course and higher for vertical course, whereas no loop course was found in our study. Sample size, racial and ethnical factors might have been responsible for the observed differences.

The most common configuration in our study was rudimentary/ no draining duct of Santorini, followed by bifid configuration with dominant duct of Wirsung and bifid configuration with dominant duct of Santorini (Table 2). Our findings are similar to that in Turkish population, where the most commonly observed pancreatic duct configuration was rudimentary/ no draining duct of Santorini, though the frequency was comparatively less.[5] Literature reviews suggest that the most common pancreatic duct configuration is bifid with dominant duct of Wirsung drainage seen in 60 % followed by a rudimentary, nondraining duct of Santorini (30%), dominant duct of Santorini without divisum (1%) and ansa pancreatica (1.2%).[14] No statistically significant correlation was seen between gender and course or configuration of pancreatic duct in our study similar to previous ones.

Pancreatic divisum was found only in 0.8% of our study population whereas where as it has been ovserved to be present in 3 – 13 % in autopsy and ERCP studies and approximately 9 % cases in MRCP.[5] Ansa pancreatica, a rare variant showing high association with recurrent pancreatitis is seen in approximately 0.85% population in previous studies which is similar to that of our study.[15]

The pancreaticobiliary confluence has been classified as three types, that is, V type where pancreatic and biliary ducts join duodenal wall without a common channel, B-P type where the biliary duct drains into the pancreatic duct and P-B type where the pancreatic duct drains into the biliary duct.[11] Studies have revealed that the P-B type was equal to an acute angle and the B-P type was equal to a right angle.[10] A study conducted by Liu et al correlated the angle of pancreaticobiliary confluence and acute pancreatitis and found greater incidence in larger angle.[16] Due to technical limitations we could not classify the confluence accordingly and divided them into acute and right angles and found acute angle of confluence more often (69.4%). We suggest further studies where the angle of pancreaticobiliary junction should be measured and correlated with pathologies like gall bladder carcinoma, choledochal cyst, etc.

The major limitation of our study is that other modalities such as ERCP were not used for comparison and confirmation of the findings. Secretin enhanced MRCP increases the sensitivity of imaging by improving the visualization of pancreatic duct including the side ducts as well as provide information about pancreatic outflow dynamics. Due to unavailability, cost and technical limitations, secretin was not injected in any of the patients, compromising the diagnostic accuracy of our study. Hence, larger multicenter studies with secretin stimulated MRCP are highly encouraged for more detailed and explicit evaluation of pancreatic duct variants.

CONCLUSION

The most common course and configuration of pancreatic duct in our study were descending and rudimentary/absent duct of Santorini, respectively. Acute angle at pancreatico-biliary confluence with common channel was seen most often.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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