

The study of anatomy of main pancreatic duct and its variations.

Author: - Dr Malathi K¹; Dr Kishan Reddy C²

¹Assistant Professor; ²Professor and HOD; Department of Anatomy; Prathima Institute of Medical Sciences, Nagunoor, Karimnagar, Telangana, India.

Address for correspondence: Dr K Malathi, Assistant Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Nagunoor, Karimnagar, Telangana, India.

E mail ID: - kondamalathi@gmail.com

ABSTRACT

Introduction: The duct system of pancreas consists of two large ducts – Main pancreatic duct and Accessory pancreatic duct. Both these ducts drain the entire exocrine part of pancreas. Main pancreatic duct is always present while accessory pancreatic duct may be absent in 30% cases. The study of duct system of pancreas has wide application in pancreatitis, endoscopic retrograde cholangio-pancreaticogram, pancreatic calculi, carcinoma of pancreas and even in obstructive jaundice caused by gall stone disease and also in gall bladder carcinoma.

Materials & Methods: The present study was done in 50 adult formalin fixed pancreatic specimens removed during posterior abdominal wall dissection.

Statistical analysis: Done using Mean, Standard deviation, Percentage

Results: The study showed that the mean length and standard deviation of the main pancreatic duct was 18.4 ± 2.43 cm and the mean width and standard deviation of the duct was 2.7 ± 0.8 mm, 2.3 ± 0.5 mm, 2.1 ± 0.2 mm respectively in the head, body and the tail. The main pancreatic duct coursed from tail to its opening into the duodenum through five various types Descending (46%), Vertical (4%), Loop (2%), Sigmoid (30%) and Horizontal (18%). The main pancreatic duct opened into the major duodenal papillae in 72% specimens.

Conclusion: The mean length of the main pancreatic duct varies from 13.4 to 26 cm, while the width of the duct gradually increases from tail to head. Descending type was most common while loop type was least common type of the main pancreatic duct course. The main drainage route of the pancreas was through major duodenal papilla.

Keywords: Main pancreatic duct, Length, Width, Type, Drainage route

INTRODUCTION

Pancreas is a mixed exocrine and endocrine gland. The exocrine part of the gland is drained by main and accessory

pancreatic ducts. The main pancreatic duct begins in the tail of the pancreas by union of interlobular ducts, courses through the body and neck where it curves downwards, backwards and opens into the duodenum through major duodenal papilla after the formation of hepato-pancreatic ampulla by uniting with common bile duct.

The distal part of the main pancreatic duct is formed from the embryonic dorsal pancreatic duct while the proximal part of the duct is formed from the embryonic ventral pancreatic duct and also from the communication formed between the ventral and dorsal pancreatic ducts during the process of development. Thus the main pancreatic duct undergoes variations in size, course and its opening into the duodenal papillae. The non-union of the embryological ducts results in the persistence of the dorsal and ventral ducts which is called pancreas divisum / embryonic type of duct system.

The knowledge of these variations in the duct system of pancreas is very important clinically and surgically. Ductal length is the main factor influencing the choice of the surgical procedures like pancreatico-jejunostomy or pancreatic resection and its study helps in differentiating the congenital anomalies like partial agenesis of pancreas. The study of width has clinical significance in pancreatitis and pancreatic cancer/malignancy. The knowledge of course and opening of the main pancreatic duct is essential in the management of the acute or chronic pancreatitis, in endoscopic retrograde cholangio-pancreaticography and also in cholelithiasis and gall bladder carcinoma.

MATERIALS AND METHODS

The study was done in 50 adult formalin fixed specimens of pancreas and duodenum en-bloc obtained during dissection of posterior abdominal wall. The study was made regardless of age and sex.

The duct system was approached from the posterior surface of the pancreas by piecemeal dissection of the substance of the gland. The main pancreatic duct was identified first in the body of the pancreas and later it was traced to both ends i.e., tail and duodenal wall. The common bile duct and the hepato-pancreatic ampulla were exposed. The length of

the ducts was measured using a thread and a manual vernier calipers.

The duodenum was opened on the right side and the estimated entrance point for the pancreatic duct and common bile duct into the duodenal lumen was made.

The entire duct system was colored using different paints and photographs of the patterns were taken.

RESULTS

The main pancreatic duct was measured from its formation by the union of the interlobular ducts in the tail of pancreas to its termination either by uniting with common bile duct or its direct opening into the duodenum. Table no-1 shows the various measurements of the main pancreatic duct.

Table no-1

Mean length and standard deviation of the main pancreatic duct

Measurement of main pancreatic duct	Length in cm
Smallest length	13.2
Largest length	26.6
Mean length	18.4
Standard deviation of mean length	2.43

The main pancreatic duct after passing through the tail and body of the pancreas, at the level of the neck changes its course and then passes through the head in five various types before terminating into the duodenum. The five various patterns include Descending, Sigmoid, Vertical, Loop and Horizontal.

- A. *Descending*: The duct gradually descends from the neck of pancreas before opening into the duodenum.
- B. *Sigmoid*: The ducts makes an 'S' shaped curve before termination in to duodenum.
- C. *Vertical*: The duct slopes vertically downwards from neck of pancreas to duodenum.
- D. *Loop*: Main pancreatic duct gives a prominent branch which joined back the parent duct in head resulting in the formation of a closed loop which appears as a focal duplication. It was an unusual variant.
- E. *Horizontal*: The non-union of embryological ducts results in persistence of dorsal pancreatic duct as horizontal type of main pancreatic duct.

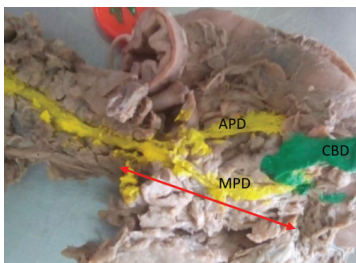


Fig No. 1
Photograph showing descending type of main pancreatic duct

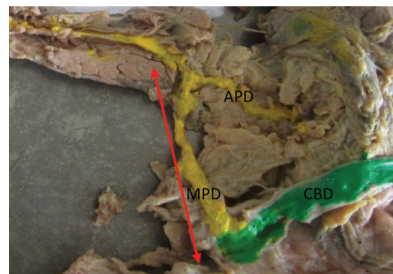


Fig No. 2
Photograph showing vertical type of main pancreatic duct

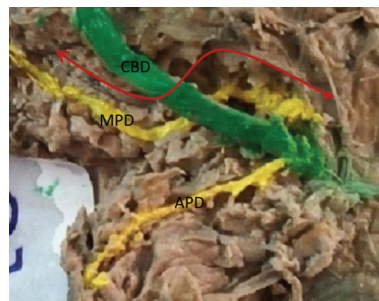


Fig No. 3
Photograph showing sigmoid type of main pancreatic duct

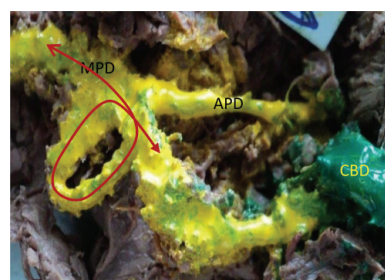


Fig No. 4
Photograph showing loop type of main pancreatic duct

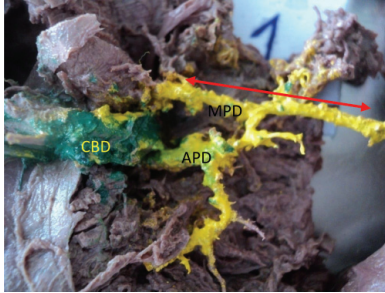


Fig No. 5
Photograph showing horizontal type of main pancreatic duct

Table no-2 shows the various courses of the main pancreatic duct and their mean lengths

Table no-2 Various types of main pancreatic ducts with their prevalence and mean length

Type of main pancreatic duct	Total no	Percentage	Mean length In cm
Sigmoid	23 /50	46%	18
Vertical	02/50	4%	16.7
Descending	15/50	30%	21.5
Loop	01/50	2%	21.5
Horizontal	09/50	18%	17.5

Width of the main pancreatic duct was measured using a manual vernier calipers approximately at the middle of each part of the pancreatic duct i.e., head, body and tail. In most of the specimens width gradually increased from tail to head.

Table no-3 shows mean width and standard deviation in various parts of the main pancreatic duct.

Table no-3 Mean width and standard deviation in various parts of the main pancreatic duct

MEAN WIDTH OF THE MAIN PANCREATIC DUCT (IN MM)		
Measured in	Mean average	Standard deviation
Head	2.7	0.8
Body	2.3	0.5
Tail	1.3	0.2

The main pancreatic duct usually united with the common bile duct to form the hepato-pancreatic ampulla which opens onto the major duodenal papilla. Sometimes it may open into minor duodenal papillae.

Table no-4 shows prevalence of main pancreatic duct opening into major and minor duodenal papillae.

Table no-4 Opening of the main pancreatic duct into major and minor duodenal papillae

Opening of main pancreatic duct is into	Number of specimans	Percentage
Major duodenal papilla	36/50	72%
Minor duodenal papilla	14/50	28%

DISCUSSION:

In the present study, the mean length of the main pancreatic duct was 18.4cm and the standard deviation was 2.4cm. Ara¹ S et al. studied the length of main pancreatic duct in Bangladeshi cadaver at different age groups in 2008 and

stated that it increased with age. The study also found that in all groups length of the main pancreatic duct was more after total removal from pancreas than in situ and x-ray. The study reported the mean \pm standard deviation of length of main pancreatic duct was 14.34 \pm 3.10 cm, 16.13 \pm 3.26 cm, 12.88 \pm 3.28 cm in situ, after total removal and in X-ray respectively.

Table no-5 Comparison of range, mean length and standard deviation of the main pancreatic duct in present study with other studies

NAME OF AUTHOR	RANGE	MEAN LENGTH AND STANDARD DEVIATION IN CM
Kang .J.K ² (1985)	-	17.5 \pm 2.8
Kochhar ³ (1996)	-	18.2 \pm 3
Sahni .D ⁴ (2001)	-	17.1 \pm 1.59(M) 15.1 \pm 1.38(F)
Ara .S ¹ (2008)	-	14.34 \pm 3.10
Tehreem Fatima ⁵ (2010)	10.2 - 20	14.76 \pm 2.3
Wilasrusmee.C ⁶ (2013)	-	15.6 \pm 1.8
Lucas N Pina ⁷ (2013)	8.6– 22.9	15.76
Govindraj .N ⁸ (2017)	7 - 15	11.1
Present study	13.2–26.6	18.4 \pm 2.43

In the present study, the most commonly observed course of main pancreatic duct was descending type(46%) followed by sigmoid type (30%) and vertical type (4%).The least commonly seen was Loop type (2%), observed only in one case. Ducts which do not fall into above said four types are grouped separately in other type-straight or horizontal (18%).

In literature, the course of main pancreatic duct varies greatly and the most commonly reported type is descending (50%) and the rest (50%) included vertical, sigmoid and loop.

Various authors like Kasugai⁹ et al.(1972), KreeI¹⁰ et al.(1973) and J.K. Kang² et al. (1989) observed the different courses of the main pancreatic duct from the duodenal papillae as upward(48.5%), vertical(26.5%), sigmoid(16.2%) and downward(8.8%); oblique(37%), sigmoid(27%) and L(27%) types; and ascending (51.7%), descending (0.7%), horizontal (22.4%) and sigmoid(25.2%) types respectively. Gonoi¹¹ et al. (2016) reported that 2.2% (11/504) of subjects had loop type of accessory pancreatic duct similar to present study.

Table no- 6 Comparison of various types of main pancreatic duct in present study with other studies

NAME OF AUTHOR	TYPE OF THE MAIN PANCREATIC DUCT		
	Z.H. Adibelli ¹² 2013-2015	Shu ¹³ 2013	Present study
No. Of specimens	1158	300	50
Descending type	724(62.5%)	192(64.0%)	23(46%)
Vertical type	68(5.5%)	32(10.7%)	2(4%)
Sigmoid type	343(30%)	48(16%)	15(30%)
Loop type	23(2%)	28(9.3%)	1(2%)

In the present study, the mean width (diameter) of the main pancreatic duct in head, neck and tail of pancreas and their standard deviations are $2.7 \pm 0.8\text{mm}$, $2.3 \pm 0.5\text{mm}$ and $1.3 \pm 0.2\text{mm}$ respectively. Various authors reported that the width of the main pancreatic duct gradually increases from tail to head as more and more interlobular ducts join; measurements in the body and tail seems to be a more sensitive indicator of pancreatic duct dilation as compared with the head. Maximum normal width of the main pancreatic duct was said to be 7mm in the book of radiology of pancreas. In a study done by Ladas SD¹⁴ in 1993 the upper range of normal

pancreatic duct width obtained was 8.0 mm, 4.0 mm and 2.4 mm in the head, body and tail, respectively, while in the present study it was found 10mm, 6.4mm and 4.4mm. Mark D Edge¹⁵ et al. in 2007 stated that while there were no strict criteria for diagnosis of main pancreatic duct dilation, generally if the main pancreatic duct measures greater than 3 mm in the head and 2 mm in the body or tail of the pancreas, it was considered enlarged. According to the study done by Anand¹⁶ et al., it was concluded that aging results in the dilatation of both the main pancreatic duct and accessory pancreatic duct; this alteration was seen mainly after the sixth decade.

Table no-7

NAME OF AUTHOR	MEAN AVERAGE WIDTH AND STANDARD DEVIATION IN MM		
	Head	Body	Tail
Varley ¹⁷ (1976)	3.1	2.0	0.9
Hadid A ¹⁸ (1983)	3.0	2.1	1.6
Kang Jk ² (1989)	3.3 ± 0.8	2.4 ± 0.5	1.5 ± 0.5
Karak ¹⁹ (1991)	2.63(<40yr), 3.31(>40yr)	1.95(<40yr), 2.34(>40yr)	0.99(<40yr), 1.23(>40yr)
Kochhar ³ (1996)	3.7 ± 0.8	2.7 ± 0.6	1.7 ± 0.4
R.Manfredi ²⁰ (2013)	3.5	2.5	1.5
Lucas N Pina ⁷ (2017)	3.44	2.34	2.34
Govindraj N ⁸ (2017)	2.9	2.33	1.49
Present Study	2.7 ± 0.8	2.3 ± 0.5	1.3 ± 0.2

In the present study, 72% of the main pancreatic ducts opened into major duodenal papilla and 28% into minor duodenal papilla. So the major drainage route of pancreas was considered to be major papilla. Narayanan Govindraj⁸ studied

in 50 cadavers in 2017 and reported that the main pancreatic duct opened into the major duodenal papilla in 52% of specimens and considered it as major drainage route of pancreas.

Table no- 8 Comparison of opening of the main pancreatic duct into major and minor duodenal papillae in present study with other studies

NAME OF AUTHOR	OPENING INTO MAJOR PAPILLA	OPENING INTO MINOR PAPILLA
Ann S Fulcher ²¹ (1999)	91%	9%
Sahni D ⁴ (2001)	96%	4%
Danhart ²² 2004)	91%	9%
Govindraj N ⁸ (2017)	52%	48%
Present study	72%	28%

CONCLUSION:

The *mean length* of the main pancreatic duct varies from 13.4 to 26.cm.

The *mean width* of the duct gradually increases from tail to head with the mean width being 1.3mm, 2.3mm and 2.7mm respectively in the tail, body and head of pancreas.

The *type/course* of the main pancreatic duct depends on the method of development of the communication between main and accessory pancreatic ducts. Descending type was the most common while loop type was the least common type. The prevalence of vertical and sigmoid course was markedly different which may be because of ethnicity. Horizontal type was the persistent embryonic dorsal pancreatic duct.

The *main drainage route* of the pancreas is through major duodenal papilla. The opening of main pancreatic duct into minor duodenal papilla may be due to non union of pancreatic ducts, after fusion of dorsal and ventral pancreas during development. This type of drainage pattern here was associated with development of communication between the main and the accessory pancreatic duct to reduce load on the minor papilla while diverting some of its contents into duodenum through major papilla; or it was not involved in the formation of hepato-pancreatic ampulla thus preventing the load of common bile duct on the smaller minor papilla.

REFERENCES

1. S Ara, Shahriah S, Begum S. The length of main pancreatic duct in Bangladeshi cadaver at different age groups. Mymensingh Med J. 2011 Apr;20(2):298-30.
2. Kang JK, Chung JB, Moon YM, Choi HJ. The normal endoscopic pancreatogram in Koreans. Korean Journal of Internal Medicine. (1989).
3. Kochhar. Narayanan govindraj, shabna. C. Variations in the duct system of pancreas: A cadaveric study. Int j anat res 2017;5(3.1):4136-4143. Doi: 10.16965/ijar.2017.269.
4. Sahni D, Jit I, Harjeet. Gross anatomy of the pancreatic ducts in north Indians . Trop Gastroenterol. 2001 Oct-Dec;22 (4):197-201.
5. Tehreem Fatima. Anatomical Variants of Pancreatic Duct System In Human Cadavers, jfjmc, vol.4, jul – sept 2010.
6. Wilasrusmee.C, Pongchairerks P. Pancreaticobiliary ductal anatomy in Thai people. J Hepatobiliary Pancreat Surg. 1999;6(1):79-85.
7. Lucas .N. Pina, Does the Accessory Pancreatic Duct have any Protective Role in Acute Biliary Pancreatitis? Anatomical Findings from Cadaver Dissections , MOJ Anat & Physiol 2016, 2(7): 00071.
8. Narayanan Govindraj, Shabna.C 2. Variations in the duct system of pancreas: a cadaveric study International Journal of Anatomy and Research, Int J Anat Res 2017, Vol 5(3.1):4136-43. ISSN 2321-4287.
9. Kasugai T, Kuno N, Nobayashi S. Endoscopic pancreatocholangiography. I. The normal endoscopic pancreatocholangiogram. Gastroenterology 63:217. 1972;
10. Kreel L, Sandin B, Slavin G. Pancreatic morphology. A combined radiological and pathological study. Clin Radiol 24:154. 1973;
11. Gono. Akai H, Hagiwara K, Akahane M, Hayashi N, et al. (2011) Pancreas divisum as a predisposing factor for chronic and recurrent idiopathic pancreatitis: initial in vivo survey. Gut 60: 1103–1108.W.
12. Zehra Hilal Adebilli, Anatomic variations of the pancreatic duct and their relevance with the Cambridge classification system: MRCP findings of 1158 consecutive patients . Radiol Oncol 2016; 50(4): 370-377.
13. Shu.J, Zhang XM, Zhao JN, Zeng NL Normal pancreatic duct: Evaluation with MR cholangiopancreatography .Chinese Journal of Medical Imaging Technology 2006; 22(4):584-7 .
14. Ladas SD. Tassios PS, Giorgiotis K, Rokkas T, Theodosiou P, Raptis SA Pancreatic duct width: its significance as a diagnostic criterion for pancreatic disease. Hepatogastroenterology. 1993 Feb;40(1):52-5.
15. Mark D Edge. Edge MD, Hoteit M, Patel AP, Wang X, Baumgarten DA, Cai Q. Clinical significance of main pancreatic duct dilation on computed tomography: Single and double duct dilation. World Journal of Gastroenterology : WJG. 2007;1 3(11):1701-1705. doi:10.3748/wjg.v13.i11.1701.
16. S Anand Rani. ,Sumathi Latha,Patency of accessory pancreatic duct and its relation with duodenal inter papillary distance, S. Indian J Gastroenterol (2012) 31: 24. https://doi.org/10.1007/s12664-011-0150.
17. Varley PF, Rohrmann CA Jr, Silvis SE, Vennes JA .The normal endoscopic pancreatogram. Radiology. 1976 Feb;118 (2):295-300.
18. Hadid A. Pancreatic duct diameter: sonographic measurement in normal subjects. J Clin Ultrasound. 1983 Jan;11(1):17-22
19. Karak PK, Vashisht S, Tandon RK, Berry MN Normal endoscopic pancreatogram in an Indian referral hospital. Indian J Med Res. 1991 Dec;94:426-9.

20. Manfredi. Magnetic Resonance Cholangiopan creatography (MRCP): Biliary and Pancreatic Ducts. Riccardo Manfredi, Roberto Pozzi Mucelli.2013.Pg 20-30
21. Ann.s.fulcher. Turner MA, Capps GW, Zfass AM, Baker KM, Half-Fourier RARE MRCP in 300 subjects. Radiology 1998; 207: 21-32.
22. Dahnert. Oxford handbook of Medical Imaging, 7th Edition, Michael J Darby, Dominic A Barron, Rachel E Hyland, 2012, Pg:341-357.

How to cite this article : Malathi K , Kishan Reddy C. The study of anatomy of main pancreatic duct and its variations. Perspectives in Medical Research 2019; 7(2):31-37

Sources of Support: Nil,Conflict of interest:None declared.