

Morphometric and Morphological Variations of the Main Pancreatic Duct: A Cross-sectional Cadaveric Study

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ABSTRACT

Introduction: The pancreatic ductal system consists of two major ducts: the main pancreatic duct and the accessory pancreatic duct. These ducts drain the exocrine part of the pancreas. Knowledge of the anatomical variations of the pancreatic duct system is important during procedures such as Endoscopic Retrograde Cholangiopancreatography (ERCP) and Magnetic Resonance Cholangiopancreatography (MRCP).

Aim: To study the morphometric and morphological variations in the course of the main pancreatic duct.

Materials and Methods: This cross-sectional cadaveric study was conducted on 50 formalin fixed pancreatic specimens from October 2023 to November 2025 in the Department of Anatomy, Kanyakumari Government Medical College,

Asaripallam, Kanyakumari, Tamil Nadu, India. The pancreases were dissected, and the main pancreatic duct was traced to study its length, width, and course pattern. Measurements were taken using thread and vernier calipers, and the course patterns were documented.

Results: The present study showed that the mean length of the main pancreatic duct was 17.5 ± 2.8 cm. The mean width of the duct was 3.1 ± 0.4 mm in the head, 2.4 ± 0.3 mm in the body, and 1.3 ± 0.3 mm in the tail. Out of the 50 pancreases studied, 25 showed a descending pattern (50%), 24 showed a sigmoid pattern (48%) and one specimen showed a loop pattern (2%).

Conclusion: Knowledge of the course and opening of the duct is essential in the management of pancreatitis, gallbladder carcinoma, and cholelithiasis.

Keywords: Anatomical variation, Cadaver, Duct of Wirsung, Pancreatitis, Patterns

INTRODUCTION

The name 'pancreas' is derived from the Greek words 'pan' (all) and 'kreas' (flesh). The pancreas is a retroperitoneal organ and it is divided into head, neck, body and tail. It weighs approximately 80 g, of which 80-90% is exocrine acinar tissue organised into lobules. The pancreas differentiates into exocrine and endocrine elements between the 12th and 40th weeks of foetal life. The primitive ducts and their ductules are responsible for the lobular arrangement of the pancreas. The anatomy of the pancreatic duct is variable because of the primordial bud development [1,2].

The main pancreatic duct arises in the tail of the pancreas. The duct lies midway between the superior and inferior margins, slightly more posterior than anterior through the tail and body of the pancreas. About 15-20 short tributaries enter the duct at right angles; superior and inferior tributaries tend to alternate (herringbone pattern). The anterosuperior portion of the head is expected to be drained by the accessory pancreatic duct into the duodenum at the minor duodenal papilla or into the main pancreatic duct [3].

The pancreatic duct is the widest at the head and gradually tapers towards the tail. The main duct and the side branches may be even wider in older people. The lateral branches from the main ducts are more numerous at the head, and these taper towards the periphery [4,5].

Despite its clinical importance, limited cadaveric data are available on the morphometry and course variations of the main pancreatic duct in the Indian population. Understanding these variations is essential for improving surgical outcomes and reducing procedural complications.

MATERIALS AND METHODS

The present cadaveric cross-sectional study was conducted in the Department of Anatomy, Kanyakumari Government Medical College, Asaripallam, Kanyakumari, Tamil Nadu, India, from October 2023 to November 2025. A total of 50 specimens were included in the present study. The pancreas specimens were procured

from the cadavers used for routine academic dissection. The specimens were taken from the cadaver of the unclaimed body of Non medicolegal case given by the administrative department. This study was conducted in accordance with ethical guidelines for cadaveric dissection and was approved by the Institutional Ethics Committee in May, 2024 (Ref.No.UG-010/IEC/2024).

Inclusion and Exclusion criteria: Intact and well-preserved formalin fixed pancreas specimens were included in the study and damaged or diseased ones were excluded.

Study Procedure

Piecemeal dissection was done from the posterior surface of the gland to expose the ducts. The main pancreatic duct was first identified in the body of the pancreas, and its complete course was then traced. A thread was maintained along the course of the main pancreatic duct from its formation till its opening, and a ruler was used to measure the thread after it was cut [6].

The width of the duct was measured using manual vernier calipers with a least count of 0.01 mm at the head, body and tail. The ductal width was measured at predetermined points in the head, body and tail regions of the pancreas, specifically at the midpoint of each region to maintain uniformity across specimens [6]. All morphometric measurements were performed by a single observer to eliminate interobserver variability. The pattern of the main pancreatic duct before it opens into the duodenum was visualised and documented. These patterns include sigmoid, descending, horizontal, vertical and loop [Table/Fig-1] [5].



[Table/Fig-1]: Patterns of main pancreatic duct include sigmoid, descending, horizontal, vertical and loop [5].

STATISTICAL ANALYSIS

Descriptive statistics such as mean, standard deviation, frequency and percentage were calculated.

RESULTS

Among the 50 specimens, 22 (44%) had a duct length between 12-17 cm, while 28 (56%) had a length between 17.1-22 cm. The mean length and standard deviation was 17.5±2.8 cm [Table/Fig-2-4].

Measurement of main pancreatic duct	Length (in cm)
Smallest length	12.2
Longest length	21.9
Mean length	17.5±2.8

[Table/Fig-2]: Length of the main pancreatic duct.



[Table/Fig-3]: Longest main pancreatic duct observed in the study.



[Table/Fig-4]: Shortest main pancreatic duct observed in the study.

In the present study, the mean width of the main pancreatic duct in the head, body and tail of the pancreas was 3.1±0.4 mm, 2.4±0.3 mm and 1.3±0.3 mm, respectively [Table/Fig-5].

Measured in	Mean width with standard deviation (in mm)
Head	3.1±0.4
Body	2.4±0.3
Tail	1.3±0.3

[Table/Fig-5]: Width of the main pancreatic duct measured in head, body and tail of pancreas.

Three patterns were observed in the present study: descending 25 (50%), sigmoid 24 (48%) and loop 1 (2%) [Table/Fig-6-9].

Type of main pancreatic duct	n (%)
Descending	25 (50)
Sigmoid	24 (48)
Loop	1 (2)

[Table/Fig-6]: Different types of main pancreatic duct with their incidence.

DISCUSSION

In the present study, the mean length of the main pancreatic duct was 17.5 cm, with a standard deviation of ±2.8 cm. Pancreatic duct length plays an important role in determining the choice of surgical procedures, including pancreatico-jejunostomy and pancreatic resection, and this serves as a valuable parameter in distinguishing

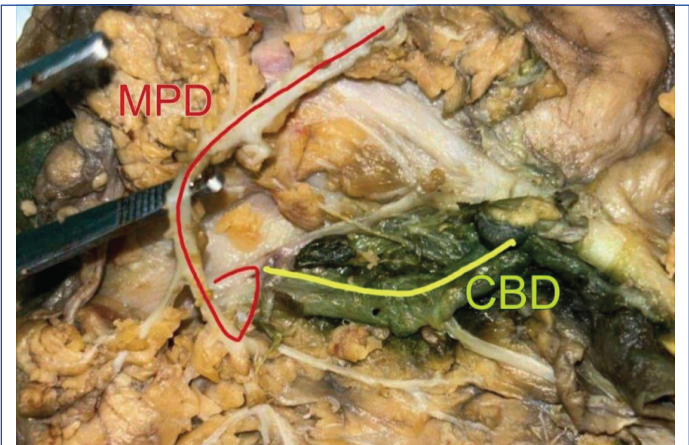
congenital anomalies such as partial pancreatic agenesis [Table/Fig-10] [5-9].



[Table/Fig-7]: Descending pattern.



[Table/Fig-8]: Sigmoid pattern.



[Table/Fig-9]: Loop pattern.
MPD: Main pancreatic duct; CBD: Common bile duct

Name of the author	Range (in cm)	Mean length±standard deviation (in cm)
Ara S et al., [5]	-	16.13±3.26
Malathi K and Kishan Reddy C [6]	13.2-26.6	18.4±2.43
Govindraj N and Shabna C [7]	7-15	11.1
Asghar A et al., [8]	15.7-17.4	16.5
Nath S et al., [9]	6-19	12.66±3.1
Present study	12.2-21.9	17.5±2.8

[Table/Fig-10]: Comparison of range, mean length and standard deviation of the length of main pancreatic duct in present study with other studies [5-9].

Three course patterns were observed in the present study; the most observed course of main pancreatic duct was descending type (50%) followed by sigmoid type (48%). The least commonly seen was loop type (2%), observed only in 1 case. Vertical and horizontal types were not observed in the present study. Knowledge of variations in the pancreatic ductal system is essential for diagnosis and management of various pancreatic disorders, including pancreatitis, pancreatic necrosis, acute pancreatic fluid collection and chronic pancreatic fistulae. It also plays a crucial role in planning and execution of diagnostic and therapeutic procedures such as ERCP, MRCP, endoscopic ultrasound guided pancreaticogastrostomy, transpapillary endoprosthesis placement, and resective or decompressive pancreatic surgeries [Table/Fig-11] [6,10-14].

Name of the author	Types of the main pancreatic duct				
	Descending	Sigmoid	Horizontal	Vertical	Loop
Malathi K and Kishan Reddy C [6]	46	30	18	4	2
Adebilli ZH et al., [10]	62.5	30	2	-	5.5
Abdelkareem H et al., [11]	75.7	18.7	1.16	-	4.38
Prasad M et al., [12] (cadaveric study)	40	13.3	-	46.7	-
Koshariya M et al., [13]	78	20	-	-	2
Johansson K et al., [14]	51	36	-	10	0
Present study	50	48	-	-	2

[Table/Fig-11]: Comparison of various types of main pancreatic duct in present study with other studies in percentage [6,10-14].

In the present study, the mean width (diameter) of the main pancreatic duct in head, body and tail of pancreas and their standard deviations are 3.1 ± 0.4 mm, 2.4 ± 0.3 mm and 1.3 ± 0.3 mm respectively. It was reported by various authors that the width of the main pancreatic duct gradually increases from the tail to head as more interlobular ducts join. Knowledge of the normal width of the main pancreatic duct is important in distinguishing physiological variations from pathological dilatation seen in chronic pancreatitis, pancreatic duct obstruction and pancreatic malignancies [Table/Fig-12] [6-8,15].

Name of the author	Mean width (in mm)		
	Head	Body	Tail
Malathi K and Kishan Reddy C [6] (mean $\pm$ SD)	2.7 ± 0.8	2.3 ± 0.5	1.3 ± 0.2
Govindraj N and Shabna C [7]	2.9	2.33	1.49
Asghar A et al., [8]	3.4	2.43	1.62
Manfredi R et al., [15]	3.5	2.5	1.5
Present study (mean $\pm$ SD)	3.1 ± 0.4	2.4 ± 0.3	1.3 ± 0.3

[Table/Fig-12]: Comparison of mean and standard deviation of width (in mm) in present study with other studies [6-8,15].

Limitation(s)

A limitation of the present study is the absence of age and gender-based demographic data preventing comparative analysis between male and female subjects.

CONCLUSION(S)

These findings add to existing anatomical literature and provide baseline data that may be useful for surgeons, radiologists and gastroenterologists during diagnostic and therapeutic procedures involving the pancreas.

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