Original Article

A Research Study of Santorini Duct

Anatomy Section

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ABSTRACT

Introduction: The accessory pancreatic duct also called as dorsal pancreatic duct or Santorini duct as it is formed from the portion of dorsal bud and was first described by Santorini in 1775. It is the main drainage duct of the dorsal pancreatic bud in the embryo and enters the duodenum at the minor duodenal papilla.

Methods: The study was conducted on 30 pancreas and duodenum enblock obtained from adult cadavers in the Forensic medicine Department of Govt. Medical College, Amritsar. Length and width of accessory pancreatic duct were measured and the results were compared according to the sex and were also analysed statistically. The shape of terminal part of the accessory pancreatic duct has also been discussed with reference to patency of the duct.

Results: Length of accessory pancreatic duct ranged between 2.0-6.2cm with a mean of 3.89+ 0.85cm. Width of accessory pancreatic duct ranged between 1.33-2.01cm with a mean of 1.67+ 0.48cm.The most common terminal shape of accessory pancreatic duct observed was stick type in 63.33% and the least common was saccular type i.e. 3.33%. In decade wise division into group I (<40 yrs) and group II (>40 yrs), length of the accessory pancreatic duct did not show any alteration with age but width was significantly greater in group II as compared with group I in male and in female subjects.

Conclusion: The anatomical aberrations in the duct system of pancreas have clinical importance because they can predispose to various clinical disorders including pancreatitis and carcinogenesis. Aging also results in increase in the diameter of the pancreatic duct. Pancreas divisum is a common anatomical variation, in which the dorsal and ventral pancreatic ducts do not unite leading to inadequate pancreatic juice drainage resulting in dorsal pancreatitis.

Key Words: Accessory pancreatic duct, Dorsal pancreatic duct, Minor duodenal papilla

INTRODUCTION

The accessory pancreatic duct also called as dorsal pancreatic duct or Santorini duct is the smaller and less constant pancreatic duct in comparison with the main pancreatic duct [1] but is the main drainage duct of the dorsal pancreatic bud in the embryo. It enters the duodenum at the minor duodenal papilla (MIP) [2] which is the orifice of the accessory pancreatic duct, mostly accompanied by pancreatic tissue, situated about 2 cm ventroproximal to the major duodenal papilla [3]. Accessory pancreatic duct (APD) shows gradual increase in its dimensions with advancement of age [4,5]. On this basis the length and width of accessory pancreatic duct was studied and the results were compared according to sex and analysed statistically. The clinical significance of the study has also been thus discussed with reference to patency of the accessory pancreatic duct (APD) which depends upon duct caliber, course and its terminal shape. The most common stick type accessory pancreatic duct shows higher patency as compared to saccular type accessory pancreatic duct that shows lower patency [6]. Pancreas divisum is a common anatomical anomaly in which the ventral and dorsal pancreatic ducts do not unite embryologically [7]. With the introduction of a popular investigation like ERCP, it will not be advisable to interpret an ERCP picture without the knowledge of the normal pattern of the duct system and its variations. Keeping all the discrepancies in mind, it is thought to be worth while to study the anatomy of pancreatic ducts in the pancreas of available human cadavers [8].

HISTORY

Studies of the anatomy of the pancreas have been carried out for over 200 years. About 80 years later, Santorini 1775 described the accessory pancreatic duct [3]. The first pancreatic observation performed on autopsy was described by the Greek, Erasistratus of Chios (319-250 B.C) [5,9]. From the historical aspect, the duct of pancreas was discovered first of all in a rooster by Moritz-Hoffmann (1641) [10]. This was followed by the demonstration of Wirsung (1642) who dissected out the duct in human pancreas [11]. This was further elaborated by the discovery of pancreatic juices as the secretion of the pancreas by Regnier-De-Graff and Franciscus Sylvius (1664) [12] Hence a proper interpretation of pancreatic physiology was possible for the first time. The relationship between the pancreas and diabetes-mellitus was established by Van Mering and Minkawski (1889) [13]. The relationship between pancreatic embryogenesis and the anatomy of the duct was established later on. The role of the pancreas and understanding it led to the development of pancreatic surgery. The first pancreatic resection was described by Kausch in 1912 [14].The pancreas varied in size, density and in the location of the pancreatic duct within the cut-line. Various authors have suggested that a uniform system of locating the pancreatic duct would be useful for future anatomical studies and comparisons. The credit for the first description of the accessory pancreatic duct goes to Santorini (1775) [15] who gave the idea of arrangement of ducts in adult human pancreas.

EMBRYOLOGY

The variations in the accessory pancreatic ductal anatomy result from abnormalities in embryological development of the pancreas from dorsal bud. Pancreas develops by the formation of ventral and dorsal buds that communicate with the foregut through a duct. The pancreas presents a complicated embryogenesis between the 5th and the 7th week of gestation [16] when the ventral pancreas fuses with the dorsal pancreas. During the fusion, the ventral and the dorsal ducts form the main pancreatic duct. The accessory pancreatic duct is formed from the portion of the dorsal bud which gives rise to the upper pancreatic head. A disorder during the complicated embryological development of the pancreas at this stage can lead to congenital abnormalities like Pancreatic divisum [7,17], complete agenesis of the pancreas which is incompatible with life [18] and agenesis of the ventral pancreas [19].

MATERIAL AND METHODS

Inclusion Criteria

1. 30 pancreas and duodenum enblock
2. The specimens were completed in all respects, in order to give the correct observations

Our findings are based on the investigation and study of 30 pancreas and duodenum enblock of both the sexes obtained from adult cadavers. The dissection was done in the Forensic medicine Department of Govt. Medical College, Amritsar. Length and width of accessory pancreatic duct were measured and compared between males and female cadavers.

The duodenum was opened along the convex. Contrast medium was injected through the catheter The patencies of major and minor duodenal papillae were checked by observing the exit of injected material through them and were finally visualized by magnifying lens. Based on this Kamisava T (2010) [6] showed the relationship between the patency of the accessory pancreatic duct and its terminal shape.

The specimens were fixed by keeping in 10% formalin for 3 days and then washed and fixed on wooden board with paper pins. The main pancreatic duct and accessory pancreatic ducts along with their tributaries and pancreatic portion of common bile duct were dissected in situ from its posterior aspect. The measurement of the length of accessory ducts was measured from the minor duodenal papilla to the junction of the accessory duct with the main pancreatic duct. The width of accessory ducts was measured from the mid point of the length of accessory pancreatic duct. The readings were statistically compared in male and female cadavers as shown in [Table/Fig-1]. In the total number of 30 specimens 20 belonged to the male subjects and 10 belonged to female subjects and they were divided by decade from 17 to 62 years and for statistical analysis into young group i.e group I which was less than 40 years (<40yrs.) and older group that was more than 40 years i.e (≥40 yrs). The findings of the present study were compared with the previous observations, as shown in the [Table/Fig-2].

DISCUSSION

In the present work the total number of specimens taken were 30, out of which 20 belonged to male subjects and 10 belonged to female subjects. In males the age ranged between 17-62 years In females the age ranged between 22-55 years In the total series the minimum age taken was 17 years while as maximum age was 62 years. As can be depicted from [Table/Fig-1] that the length of accessory pancreatic duct ranged between 2.0 -6.2 cm with a mean of 3.89± 0.85 cm in 29 specimens. In males [20] the length ranged between 2.9 -6.2 cm with a mean of 4.26± 0.89 cm. In females [9] the length of accessory duct ranged between 2.0-4.5 cm with a mean of 3.19 ± 0.76 It was statistically significant. In one case which was belonged to female series, the accessory duct was not seen. It was concluded that aging results in the dilation of both the MPD and APD; this alteration was seen mainly after the sixth decade.

A glance at [Table/Fig-1] also shows that the width of accessory pancreatic duct ranged between 1.33-2.01cm with a mean of 1.67± 0.48cm in 29 specimens. In males [20] the width ranged between 1.38–2.01cm with a mean of 1.69±0.44cm. In females [9] the width of accessory duct ranged between 1.33-1.96cm with a mean of 1.64 ±0.44cm. It was statistically significant. In one case belonging to female series, the accessory duct was not seen.

The findings of the present study were compared with the previous observations, as shown in the [Table/Fig-2]. They were divided by decade from 17 to 62 years into younger group i.e group I (<40yrs.) and older group i.e group II (≥40 yrs.). Length of the accessory pancreatic duct (APD) did not show any alteration with age but width was significantly greater in group II as compared with group I as shown in [Table/Fig-2]. Not much difference was observed in the length and width of the accessory pancreatic duct (APD) between male and female subjects of either group. It is concluded that aging results in the dilation of accessory pancreatic duct and this alteration is seen mainly after the sixth decade. The results thus were obtained in accordance with the work done by Anand et al [5], none of the earlier authors have mentioned the comparison between male and female group.

Contrast medium was injected through the catheter to judge the patencies of major and minor duodenal papillae. Excretion of the dye from the minor duodenal papilla was observed by magnifying lens. Thus different Shapes of terminal accessory pancreatic duct was observed as Stick, Spindle, Cudgel, Saccular and Branch. Based on this Kamisava T showed the relationship between the patency of the accessory pancreatic duct and its terminal shape as seen in [Table/Fig-3]. In the present study the most common shape observed was stick type in 63.33% which shows significantly higher patency of accessory pancreatic duct (APD) and the least common was saccular type i.e. 3.33% which shows significantly lower patency of APD. These values were in accordance with the work done by Kamisava [6].

In one case belonging to female series, the accessory duct was not seen.

RESULTS

In total number of 30 specimens 20 male subjects and 10 female subjects were studied for length and width of accessory pancreatic duct as in one female specimen the accessory pancreatic duct was not seen. Based on these observations, the range and mean were calculated for each parameter according to the sex and results were also analysed statistically.

The length of accessory pancreatic duct ranged in males (20) ranged between 2.9 -6.2 cm with a mean of 4.26± 0.89 cm and in females (9) the length ranged between 2.0 - 4.5 cm with a mean of 3.19 ± 0.76 which was found to be statistically significant.

The width of accessory pancreatic duct ranged between 1.38-2.01cm with a mean of 1.69±0.44cm in males (20) and 1.33-1.96cm with a mean of 1.64±0.44cm in females (9) and was statistically significant.

Sex	No.	Length of accessory pancreatic duct		Width of accessory pancreatic duct	
		Range (cm)	Mean ± SD	Range(cm)	Mean ± SD
Males	20	2.9–6.2	4.26 ± 0.89	1.38-2.01	1.69 ± 0.44
Females	09	2.0–4.5	3.19 ± 0.76	1.33-1.96	1.64 ± 0.44
Total	29	2.0–6.2	3.89 ± 0.85	1.33-2.01	1.67 ± 0.48

[Table/Fig-1]: Comparison of Length and Width of Accessory Pancreatic Duct According to Sex

Worker	Year	Groups		Number	Length	Width
Anand et al [5]	1989	GroupI (<40yrs.)		–	–	1.49 ± 0.51
		GroupI (>40yrs.)		–	–	1.94 ± 0.69
Present Study	2011	GroupI (<40yrs.)	Male	9	3.9±0.21	1.42±0.024
			Female	3	3.3±0.24	1.34±0.013
		GroupI (>40yrs.)	Male	11	4.1±0.19	1.98±0.020
			Female	6	3.8±0.23	1.82±0.024

[Table/Fig-2]: Comparison between Length and Width of Accessory Pancreatic Duct

Shape of terminal accessory pancreatic duct	Kamisava T et al[6] 2010		Present Work 2011	
	No. of cases (265)	%age	No. of cases (30)	%age
Stick	149	56.22	19	63.33
Spindle	29	10.94	4	13.33
Cudgel	24	9.43	2	6.66
Saccular	21	7.92	1	3.33
Branch	42	15.8	3	10

[Table/Fig-3]: Comparison of Shape of Accessory Pancreatic Duct

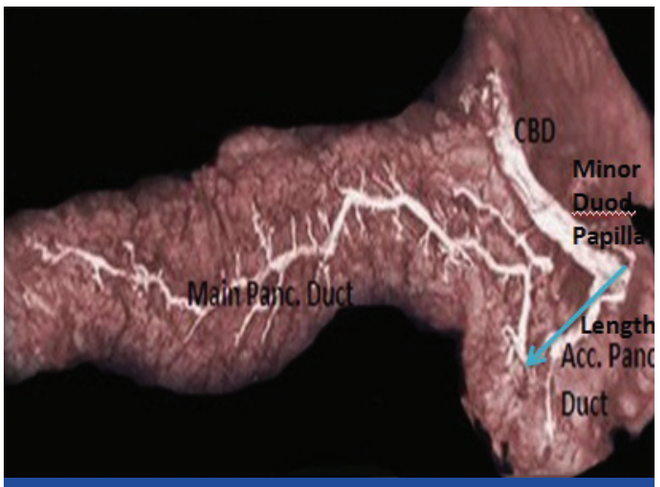
When divided decade wise into group I (<40 yrs) and group II (>40 yrs) Length of the accessory pancreatic duct (APD) did not show any alteration with age but width was significantly greater in group II (1.98 ±0.020) as compared with group I (1.42 ±0.024) in male subjects and also greater in group II (1.82±0.024) as compared to group I (1.34±0.013) in female subjects.

Relationship between the patency of the accessory pancreatic duct and its terminal shape was also observed. The most common shape observed was stick type in 63.33% and least common was saccular type in 3.33%.

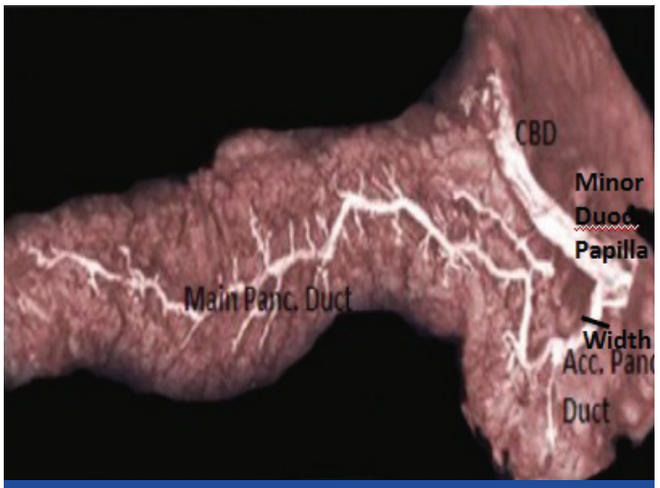
CONCLUSION

Thus to conclude, it can be stated that:

1. Aging results in the dilation of accessory pancreatic duct; this alteration is seen mainly after the sixth decade. Studies in the West have shown that with advancing age there is progressive atrophy and fibrosis of the pancreas. In addition, there is a gradual increase in diameter of the pancreatic duct with age [4,5].
2. The problem of pancreatitis happens to be old one. Possibilities suggests that anatomical anomalies in the duct system of pancreas can cause pancreatitis and various clinical disorders [8].A patent accessory pancreatic duct may prevent acute pancreatitis by lowering the pressure in the main pancreatic duct [3].
3. A patent accessory pancreatic duct also lowers the incidence of carcinogenesis of the biliary tract in cases of the pancreaticobiliary maljunction with patent APD, as the reflux of the pancreatic juice to the bile duct might be reduced by the flow of pancreatic juice from the upper dorsal pancreatic duct (APD) into the duodenum via the minor duodenal papilla [3].
4. Pancreas divisum is a common anatomical variation, in which the dorsal and ventral pancreatic ducts do not unite embryologically. In cases of pancreas divisum, inadequate pancreatic juice drainage from the minor papilla might occur, resulting in dorsal pancreatitis [6,17]. Cystic fibrosis transmembrane conductance regulator (CFTR) gene mutations are more frequently found in patients with pancreas divisum associated with idiopathic pancreatitis than in those with pancreas divisum without pancreatitis [7].
5. Sometimes ventral pancreatic duct anastomosis with dorsal pancreatic duct is narrower than dorsal pancreatic duct (DPD) itself. Such groups are known as DPD dominance and it is suggested that Dorsal Pancreatic Duct (DPD) dominant group patients have less chance of gall bladder carcinoma as compared to normal duct group [6].



[Table/Fig-4]: Picture showing length of acessory pancreatic duct Blue arrow shows the length of acessory pancreatic duct



[Table/Fig-5]: Picture showing width of acessory pancreatic duct Black line shows the width of acessory pancreatic duct

REFERENCES

[1] Kamisawa T, Egawa N, Nakajima H, Sakaki N, Tsuruta K, Okamoto A Clinical significance of the accessory pancreatic duct. *Hepatogastroenterology* 2003; 50(54): 2196-98.
[2] Kamisawa T. Clinical significance of the minor duodenal papilla and accessory pancreatic duct. *Gastroenterol* 2004; 39(7): 605-15.
[3] Suda K. Histopathology of the minor duodenal papilla. *Dig Surg* 2010; 27(2): 137-39.

[4] Birnstingl. A study of pancreatography. *The British Journal of Surgery* 1959; 47: 128-39.
[5] Anand B, Vij J, Mac V, Chowdhary V, Kumar A. Effect of aging on the pancreatic ducts: a study based on endoscopic retrograde pancreatography. *Gastrointestinal Endoscopy* 1989; 35(3): 210-13.
[6] Kamisawa T, Takuma K, Tabata T, Egawa N. Clinical implications of accessory pancreatic duct. *World J Gastroenterol* 2010; 16(36): 4499–03.
[7] Morgan DE, Logan K, Baron TH, Koehler RE, Smith JK. Pancreas divisum: implications for di agnostic and therapeutic pancreatography. *AJR* 1999; 173: 193 -98.
[8] Singh I. Observations on the mode of termination of the bile and pancreatic ducts. Anatomical factors in pancreatitis. *J. Anat. Soc. India* 1956; 5: 54-60.
[9] Kozu T, Suda K, Toki F. Pancreatic development and anatomic variation. *Gastrointest Endosc Clin N Am* 1995; 5: 1-30.
[10] Hoffmann JM. Dissertationes anatomico-physiologicae. Johannes van Horne Swammerdamii, Altdorfii Noricorum 1685; 164. Cited By John M and Walter H. Johann Georg Wirsüng and the pancreatic duct. *Journal of the American College of Surgeons* 1998; 187(2): 201-11
[11] Lehman GA, Sherman S. Diagnosis and therapy of pancreas divisum. *Gastrointest Endosc Clin N Am* 1998; 8: 55-77.
[12] Reinhoff and Pickrell. Pancreatitis: An anatomic study of the pancreatic and extrahepatic biliary systems. *Archieves of Surgery*. 1946; 51 (4): 945.
[13] Mering J V and Minkowski O. Diabetes mellitus nach Pankreasextirpation. *Arch. exp. Path. und. Pharm* 1889; XXVI: 371
[14] Soto JA, Lucey BC, Stuhlfaut JW. Pancreas di visum: depiction with multi-detector row CT. Radiology 2005; 235: 503-08.
[15] Santorini GD. Septendecim tabulae quas nunc primum edit atque explicat iisque alias addit de structura Parmensi universitate anatomes professor primarius, etc. Parmae ex regia typographia. *Fol. British Library Wellcome Institute Hist. Med* 1775; 59: 12.
[15] Lankisch PG, Banks PA. *General considerations: Embryology. Pancreatitis*. 1st edition. Berlin-Heidelberg, Germany: Sringer-Verlag; 1998: 1-14.
[16] Bret PM, Reinhold C, Taourel P, Guibaud L, Atri M, Barkun AN. Pancreas divisum: evaluation with MR cholangiopancreatography. *Radiology* 1996; 199: 99-103.
[17] Voldsgaard P, Kryger-Baggesen N, Lisse I. Agenesis of pancreas. *Acta Paediatr* 1994; 83: 791-93.
[18] Guclu M, Serin E, Ulucan S, Kul K, Ozer B, Gumurdulu Y, et al. Agenesis of the dorsal pancreas in a patient with recurrent acute pancreatitis: case report and review. *Gastrointest Endosc* 2004; 60: 472-75.

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