

Internal Diameter of the Main Pancreatic Duct – A Post Mortem Study

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Abstract

Context: Main pancreatic duct is an important vessel for transport of pancreatic exocrine secretion. It gradually tapers towards the tail. Progressive narrowing of the internal diameter of the main pancreatic duct is dangerous for removal of pancreatic or dislodged gallbladder calculi.

Study design: A descriptive type of study.

Place and period of study: The study was carried out in the Department of Anatomy, Dhaka Medical College, from August 2005 to December 2006.

Materials: The present study was performed on 75 male humans. The samples were collected from the unclaimed dead bodies within 24 hours after death that were under examination in the Department of Forensic Medicine of Dhaka Medical College, Dhaka.

Method: The samples were divided into 7 different age groups and comparative studies were made between different groups. All samples were studied morphologically. Internal diameter of the main pancreatic duct was measured at four points with the help of a dissecting microscope.

Result: Internal diameter of the main pancreatic duct increased progressively with age, which showed positive correlation and was statistically significant ($P < 0.001$).

Conclusion: Further studies with large sample in both sexes, comparison of internal diameter of main pancreatic duct with *in situ* X-ray, corrosion cast of the pancreatic ductal system, pancreatic ductal histological studies are recommended.

Key words: Main pancreatic duct, internal diameter.

Introduction:

Main pancreatic duct was described by Wirsung in 1642¹. It arises in tail of the pancreas; receives lobular ducts, joining at the right angles (herringbone

pattern) running towards the common bile duct. It may or may not join the common bile duct and drains upper part of the head, body and tail of the gland². Usually opens at the major duodenal papilla.

A full understanding of the caliber of the main pancreatic duct is essential for any surgeon operating on the pancreas. Variations in the internal diameter of the main pancreatic duct are dangerous for removal of pancreatic or dislodged gallbladder calculi³. This makes difficulties in removal of the calculi within the duct and in ERCP (Endoscopic Retrograde cholangio pancreatogram) canulation. In case of measurement of the intraductal pressure following injection of contrast material, the diameter of the main pancreatic duct³ is directly related with the pressure with in them.

Materials and methods:

The present study was performed on 75 male pancreas in different age groups of Bangladeshi

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people. The study was done from August 2005 to December 2006.

Pancreas, stomach and duodenum were taken en block. Duodenum was separated from the stomach and jejunum. Lateral end of the duodenum was incised. The cleaned specimen was fixed with 10% formol saline in a labeled jar for 48 hours. This fixed specimen was easier for further fine dissection. After 48 hours, the site of entry of the main pancreatic duct into the duodenum with or without association of common bile duct was identified by palpation⁴. Adjoining fascia between the c-shaped curvature of duodenum and pancreas was excised after preserving external part of main pancreatic duct, minor pancreatic duct (if present) and common bile duct. Then following the main pancreatic duct; on the posterior surface of the pancreas, the lobules were picked away in piecemeal (Fig.-1) and total ductal system including main pancreatic duct, accessory pancreatic duct and common bile duct were completely separated from the pancreatic soft tissue by keeping the communication with duodenum⁵ (Fig.-2).

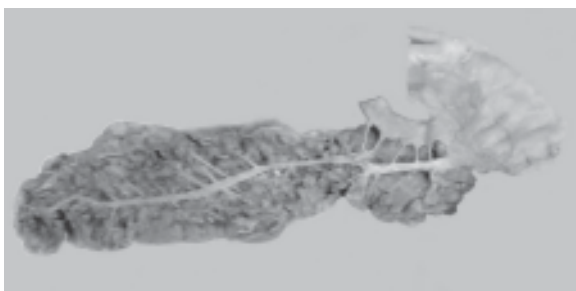


Fig.-1: Pancreatic ductal system in situ.

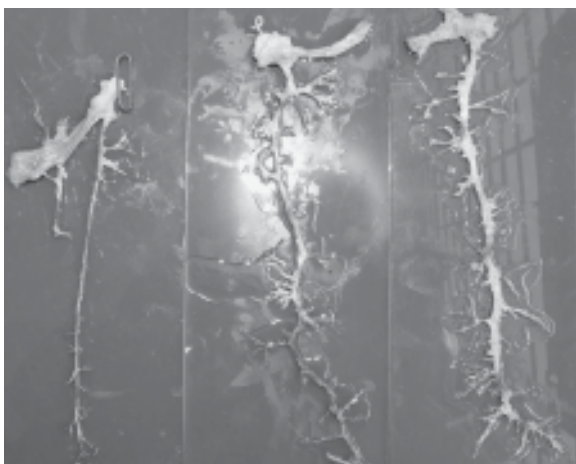


Fig.-2: Pancreatic ductal system after total removal of soft tissue.

Grouping of the samples:

The collected samples were divided into seven group (A, B, C, D, E, F, G)⁶

Table-I

Grouping of the samples in relation to age.

Group	Age limit in years
A	10-19
B	20-29
C	30-39
D	40-49
E	50-59
F	60-69
G	70 and above70

Parameters:

Internal diameter of the main pancreatic duct was measured;

- i. At 1 inch proximal to the commencement of the tail of the pancreas.
- ii. Apparently mid portion of the body region.
- iii. Just entering at the head.
- iv. Prior to join the common bile duct in case of a common opening, or
- v. Prior to open at the duodenum in case of individual opening.

Procedure of the study:

Internal diameter of the main pancreatic duct was measured with the help of a dissecting microscope. At first 1 mm was subdivided into 10 times (0.10 mm) by Visio basic soft ware 2000 version. This print was taken on a transparency sheet and cut into a little bit smaller pieces than a histology glass slide. Now the separated main pancreatic duct was cut transversely with scissor as thin as possible starting from the extreme end i.e. at the 1 inches proximal to the commencement of the tail and apparently mid portion of body region, subsequently just entering at head, lastly prior to join the common bile duct in case of a common opening or prior to open at the duodenum in case of individual opening. The cut sections were placed on a slide placed over the cut piece of the transparency sheet and put under the dissecting microscope (Fig.-3). The internal diameter (i.e. the inner aspect of the lumen) was counted that how many distance was crossed in the scale and expressed in fractions of mm⁷.

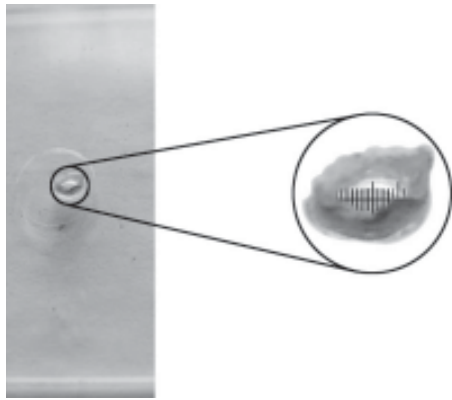


Fig.-3: Measurement of internal diameter of the main pancreatic duct.

Results:

Internal diameter of the main pancreatic duct in the head, body and tail:

Internal diameter of the main pancreatic duct in the head, body and tail is shown in table IIa and IIb, figure: 1.

Table - IIa

Internal diameter of main pancreatic duct (MPD) in the head, body and tail of different study group

Group	n	Internal diameter of MPD (mm)		
		Head	Body	Tail
		Mean±SD	Mean ± SD	Mean±SD
A	6	2.65±0.31 (2.2-3.0)	2.07±0.27 (1.7-2.5)	1.40±0.48 (0.8-2.0)
B	17	3.49±0.38 (2.9-4.0)	2.81 ±0.39 (2.1-3.6)	2.17±0.45 (1.6-2.9)
C	14	3.59±0.22 (3.2-3.9)	2.82±0.17 (2.5-3.1)	1.96±0.27 (1.6-2.6)
D	1	3.89±0.19 (3.7-4.3)	2.92±0.20 (2.5-3.2)	2.23±0.28 (2.0-2.8)
E	7	4.31±0.36 (3.7-4.7)	3.33±0.59 (2.5-4.0)	2.54±0.63 (1.8-3.5)
F	5	4.40±0.35 (4.0-4.8)	3.62±0.40 (3.0-4.0)	2.76±0.34 (2.3-3.1)
G	5	4.56±0.28 (4.1-4.8)	3.88±0.13 (3.7-4.0)	2.98±0.31 (2.5-3.3)

Figures in parentheses indicate range

Table IIb
Statistical analysis for Table IIa

Group	Head P value	Body P value	Tail P value
A vs B	<0.001**	<0.001**	<0.001**
A vs C	<0.001**	<0.001**	<0.01**
A vs D	<0.001**	<0.001**	<0.001***
A vs E	<0.001	<0.001**	<0.001**
A vs F	<0.001	<0.001**	<0.001
A vs G	<0.001**	<0.001**	<0.001**
B vs C	> 0.001,	>0.50ns	> 0.10n,
B vs D	<0.01**	> 0.10ns	> 0.50 ^o
B vs E	<0.001***	<0.01**	<0.05*
B vs F	<0.001**	<0.001**	<0.01**
B vs G	<0.001**	<0.001**	< 0.001**
C vs D	<0.05*	> 0.001ns	> 0.10 ^o
C vs E	<0.001**	<0.01**	<0.01**
C vs F	<0.001**	<0.001**	<0.001**
C vs G	<0.001***	<0.001**	<0.001**
D vs E	<0.01**	<0.05 ^x	>0.10 ^o
D vs F	<0.01**	<0.001**	> 0.001,
D vs G	<0,001*	<0.001** **	>0.05ns

Statistical analysis done by one-way ANOVA (PostHoc) test, ns = not significant, */**/** = significant

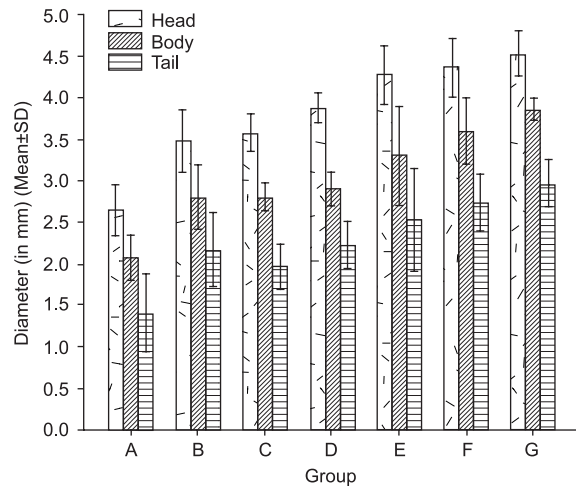


Figure-1: Internal diameter of main pancreatic duct (MPD) in head, body and tail in different age group

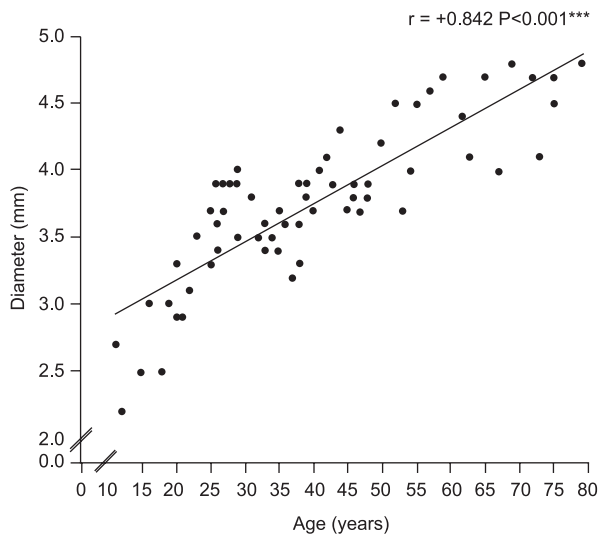


Fig-2a: Scatter diagram showing the relationship between age and internal diameter of the main pancreatic duct (MPD) in the head (n=65)

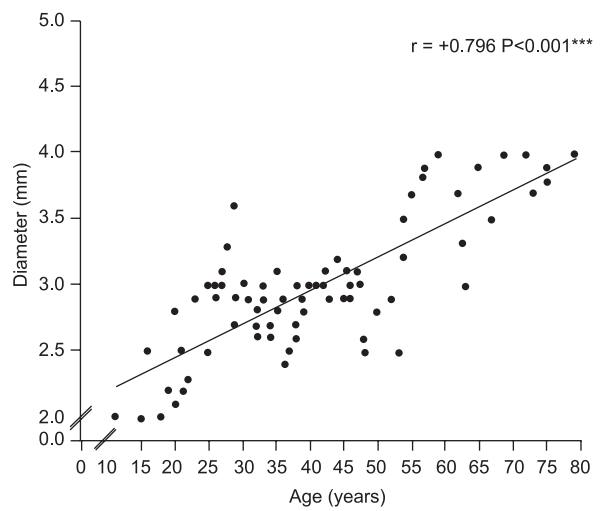


Fig-2b: Scatter diagram showing the relationship between age and internal diameter of the main pancreatic duct (MPD) in the body (n=65)

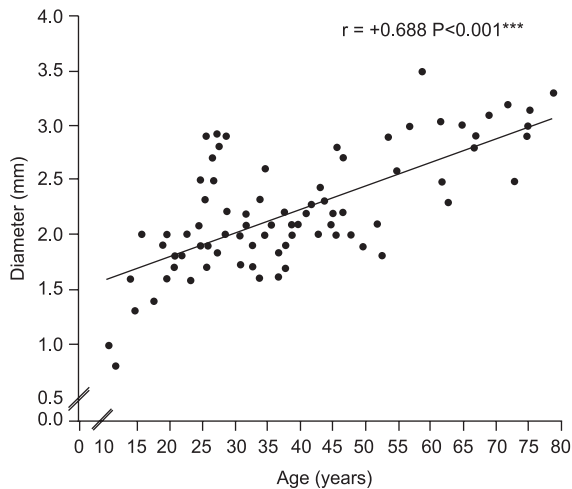


Fig-2c: Scatter diagram showing the relationship between age and internal diameter of the main pancreatic duct (MPD) in the tail (n=65)

Internal diameter of the main pancreatic duct in the head of the pancreas:

The highest mean internal diameter of the main pancreatic duct in the head was 4.56 ± 0.28 mm in group G (70 and above years) and lowest was 2.65 ± 0.31 mm in group A (10 to 19 years). The difference

between the internal diameter of the main pancreatic duct in the head was statistically significant ($p < 0.001$) in A vs B group, A vs C group, A vs D group, A vs E group, B vs E group, B vs F group, B vs G group, C vs D group, C vs E group, C vs F group, C vs G group, D vs E group, D vs F group and D vs G group. The internal diameter of the main pancreatic duct in the head increased gradually with the advanced age. Figure: 2.a show the statistically significant ($p < 0.001$) positive correlation ($r = 0.849$) between age and internal diameter of the main pancreatic duct in the head of the pancreas.

Internal diameter of the main pancreatic duct in the body of the pancreas:

In the present study the highest internal diameter of the main pancreatic duct in the body was 2.92 ± 0.20 mm in group G (70 and above years) and lowest was 2.07 ± 0.27 mm in group A (10 to 19 years). The difference between the mean internal diameter of the main pancreatic duct in the body was statistically significant ($p < 0.001$) in A vs B group, A vs C group, A vs D group, A vs E group, A vs F group, A vs G group, B vs E group, B vs F group, B

vs G group, C vs E group, C vs F group, C vs G group, D vs E group and E vs G group. The internal diameter of the main pancreatic duct in the body increased gradually with the advanced age. Figure: 2.b show the statistically significant ($p < 0.001$) positive correlation ($r = 0.796$) between age and internal diameter of the main pancreatic duct in the body of the pancreas.

Internal diameter of the main pancreatic duct in the tail of the pancreas:

The highest mean internal diameter of the main pancreatic duct in the tail was in group G (70 and above years) and the lowest was 1.40 ± 0.48 cm in group A (10 to 19 years). The internal diameter of the main pancreatic duct in the tail show progressively increasing with advanced age. The difference between the internal diameter of the main pancreatic duct in the tail was statistically significant ($p < 0.001$) in A vs B group, A vs C group, A vs D group, A vs E group, A vs F group, A vs G group, B vs E group, B vs F group, B vs G group, C vs E group, C vs F group, C vs G group and D vs E group. Figure: 2.c show the statistically significant ($p < 0.001$) positive correlation ($r = 0.688$) between age and internal diameter of the main pancreatic duct in the tail of the pancreas.

The internal diameter of the main pancreatic duct in 63 specimens gradually tapered from head to the tail end. In 1 specimen the main pancreatic duct was of the same diameter in the head and body in Group C and in the 1 specimen in Group B, the diameter of main pancreatic duct was smaller in pancreatic head than body.

Internal diameter of the main pancreatic duct out side the pancreas (before joining the common bile duct or prior to independent opening at the duodenum):

Table IIIa and IIIb, Figure: 3 show the extra pancreatic part of the internal diameter of the main pancreatic duct out side the pancreas (before joining the common bile duct or prior to independent opening at the duodenum).

Table-IIIa
Internal diameter of extra pancreatic part of main pancreatic duct (MPD) before joining common bile duct (CBD) and prior to independent opening at duodenum in different study group

Group	Internal diameter (mm)			
	Prior to joining CBD		Prior to independent opening at duodenum	
	n	Mean±SD	n	Mean±SD
A	2	3.25±0.35 (3.0-3.5)	4	3.20±0.37 (2.8-3.7)
B	8	4.09±0.32 (3.5-4.5)	9	4.28±0.37 (3.6-4.8)
C	7	4.69±0.20 (4.4-4.9)	7	4.64±0.25 (4.2-4.9)
D	5	4.86±0.11 (4.7-5.0)	6	4.85±0.15 (4.7-S. 1)
E	2	5.20±0.14 (5.1-5.3)	5	5.12±0.19 (4.9-5.4)
F	3	5.40±0.10 (5.3-5.5)	2	5.15±0.07 (5.1-5.2)
G	2	5.45±0.07 (5.4-5.5)	3	5.47±0.15 (5.3-5.6)

Figures in parentheses indicate range

Table IIIb
Statistical analysis for Table IIIa

Group	P value	P value
A vs B	< 0.001 **	<0.001**
A vs C	<0.001**	<0.001**
A vs D	<0.001**	<0.001**
A vs E	<0.001	<0.001**
A vs F	<0.001**	<0.001**
A vs G	<0.001**	<0.001**
B vs C	<0.001**	<0.05*
B vs D	<0.001**	<0.01**
B vs E	<0.001**	<0.001*
B vs F	<0.001**	<0.001**
B vs G	<0.001**	<0.001**
C vs D	> 0.10 ^{ns}	>0.10 ^{ns}
C vs E	< 0.05"	<0.01*
C vs F	<0.001**	< 0.05"
C vs G	<0.001**	<0.001**
D vs E	> 0.05 ns	> 0.10ns
D vs F	<0.01**	> 0. 10 ^{ns}
D vs G	<0.01ns	<0.01**
E vs F	> 0.10ns	> 0.50ns
E vs G	> 0.10 ns	> 0.10ns
F vs G	> 0. 50ns	> 0.10ns

Statistical analysis done by one-way ANOVA (PostHoc) test, ns = not significant, */**/** = significant

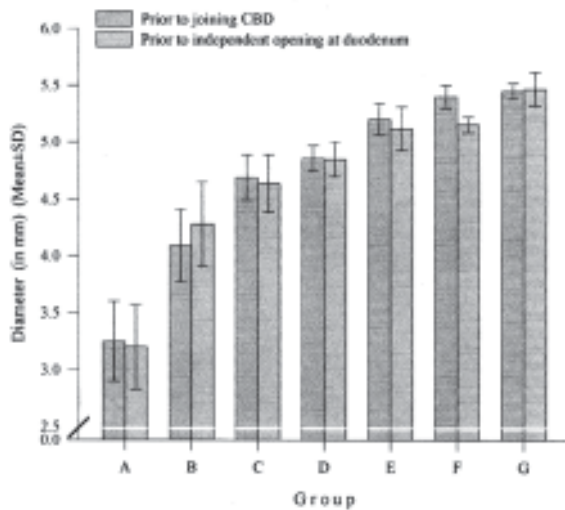


Figure-3: Internal diameter of extra pancreatic part of the main pancreatic duct (MPD) before joining the common bile duct or prior to independent opening in duodenum in different age group.

Internal diameter of the main pancreatic duct before joining the common bile duct:

The highest mean internal diameter of the main pancreatic duct before joining the common bile duct was in group G (70 and above 70 years) and the lowest was in group A (10 to 19 years). The difference between the internal diameter of the main pancreatic duct before joining the common bile duct was statistically significant ($p < 0.001$) in A vs B group, A vs C group, A vs D group, A vs E group, A vs F group, A vs G group, B vs E group, B vs F group, B vs G group, C vs E group, C vs F group, C vs G group and D vs E group. The internal diameter of the main pancreatic duct before joining the common bile duct gradually increased with the advancing age in the present study.

Internal diameter of the main pancreatic duct prior to independent opening at the duodenum: The highest mean internal diameter of the main pancreatic duct prior to independent opening at the duodenum was in group G (70 and above 70 years) and the lowest was in group A (10 to 19 years). The difference between the internal diameter of the main pancreatic duct prior to independent opening at the duodenum was statistically significant ($p < 0.001$) in A vs B group, A vs C group, A vs D group, A vs E

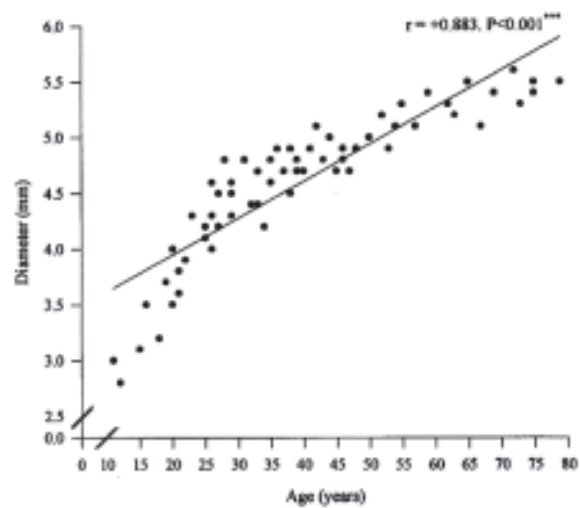


Figure-4: Scatter diagram showing the relationship between age and extra pancreatic part of internal diameter of the main pancreatic duct (MPD) outside the pancreas (n=65)

group, A vs F group, A vs G group, B vs E group, B vs F group, B vs G group, C vs E group, C vs F group, C vs G group and D vs E group. The tendency of the internal diameter of the main pancreatic duct prior to independent opening at the duodenum was found to be increased with the advanced age.

In the present study figure: 4 show the statistically significant ($p < 0.001$) positive correlation ($r = 0.883$) between age and internal diameter of the main pancreatic duct out side the pancreas (before joining the common bile duct or prior to independent opening at the duodenum).

The internal diameter of extra pancreatic part of the main pancreatic duct (before joining the common bile duct or prior to independent opening at the duodenum) in all instances found gradually tapered to wards the proximal end.

Stenosis of the main pancreatic duct out side the pancreas just before joining the common bile duct was found in 1 case of group B.

Discussion:

It is evident from this study that the internal diameter of the main pancreatic duct in the head, body and tail progressively increase with advancing age which was statistically significant ($p < 0.001$) and shows

positive correlation with age ($r = 0.883$), ($r = 849$), ($r = 0.796$) and ($r = 0.688$) respectively. Millbourn⁸ reported from autopsy and ERCP cases that the internal diameter of the main pancreatic duct increases with age. Larson et al⁹, Varley et al⁶ and Magee et al¹⁰ described from autopsy – roentgenographic study that the pancreatic ductal dilation as normal aging changes. Kim et al¹¹ noted a tendency for ductal diameters to be greater in older age group. McCarty et al¹² observed the largest diameters of a normal pancreatic duct in a 91 year woman. Axon¹³ said that the duct size varies according to age, sex, size of patient and racial origin, as well as disease. This was suggestive of increasing the internal diameter of the main pancreatic duct progressively with age

Internal diameter of the main pancreatic duct in the head, body and tail described by Birnstingl¹⁴, Millbourn¹⁵, Hand¹⁶, Trapnell and Howard¹⁷, Magee and Burdick¹⁰ in autopsy was higher than the present study. They all had measured the ductal internal diameter prior to formol saline fixation. But in this study ductal internal diameter had been measured after 48 hours in 10% formol saline fixed specimen.

The cadaveric internal diameter of the main pancreatic duct in the head, body and tail described by Berman¹⁸, Kasugai², Sivak and Sullivan¹, Varley et al⁶, Mulholland et al¹⁹ and Larson et al⁹ were similar to the present study. Whereas, Okuda et al²⁰, Ogoshi²¹, Cotton²² reported from endoscopic findings was also similar to this study. Newman²³ measured that the ductal diameters on the basis of an autopsy – roentgenographic study. This was suggestive of similar to this study.

The internal diameter of the main pancreatic duct in the head, body and tail described by Kreel and Sandin²⁴, Lawson²⁵, Axon¹³, Karim²⁶ was lower than the present study. Starling²⁷, Classen et al²⁸ found that the mean diameter of the pancreatic duct was 0.9mm, 2.03 mm. That was lower than the present study. This dissimilarity may be due to they had chosen the age group up to 60 years.

Limitation of the study:

Females are excluded due to less availability of the female cadaveric pancreas during study period.

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