



# Distribution and correlation of pancreatic gland size and duct diameters on MRCP in patients without evidence of pancreatic disease

Qiushi Wang<sup>1,2</sup> · Jordan Swensson<sup>2</sup> · Maoqing Hu<sup>2,3</sup> · Enming Cui<sup>2,3</sup> · Temel Tirkes<sup>2</sup> · Samuel G. Jennings<sup>2</sup> · Fatih Akisik<sup>2</sup>

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## Abstract

**Purpose** To use MRCP to investigate age-related changes and gender differences of the pancreas and to correlate pancreatic gland size and duct diameter.

**Methods** In this institutional review, board-approved, HIPAA-compliant study, 280 patients (age 20–88 years) without a history of pancreatic or liver disease who had undergone MRI/MRCP from 2004 to 2015 were identified. The anteroposterior size and main duct diameter of the pancreatic head, body, and tail were measured. The pancreatic gland and duct sizes were compared between genders, and among seven age subgroups (20–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80–89).

**Results** The pancreatic head and body were significantly larger in males than females (head,  $p < 0.01$ ; body,  $p = 0.03$ ), while the tail and the duct diameters of the pancreatic head, body, and tail showed no gender difference. As the age of male participants increased, there was an associated increase in size of the pancreatic gland initially (largest at age 50–59 (body) and 60–69 (head)), followed by subsequent decline in size thereafter. Additionally, the pancreatic duct diameter was found to increase gradually. In females, the size of the pancreatic gland decreased, while the diameter of the pancreatic duct increased with age. Moderate positive correlation for gland size and strong positive correlation for duct diameter among different pancreatic regions were found. Weak negative correlation was found between gland size and duct diameter.

**Conclusions** There are gender differences in the gland size of the pancreatic head and body. The pancreatic gland size increases until the sixth decade in males, with a more continuous decrease in gland size with age in females. Both males and females demonstrate a marked decrease in gland size after the eighth decade. The duct diameter increases with age in both males and females.

**Keywords** Magnetic resonance imaging · MR cholangiopancreatography · Pancreatic gland · Main pancreatic duct

## Introduction

The size of the pancreatic gland and diameter of the main pancreatic duct (MPD) are usually affected by pancreatic diseases. Changes in the gland size and ductal diameters

are important findings indicating underlying disorders [1–5]. However, the normal aging process also leads to changes in pancreatic morphology. Several studies conducted either in animals or humans have shown the pancreas undergoes morphologic changes with aging, such as atrophy, duct dilation,

✉ Fatih Akisik  
makisik@iupui.edu

Qiushi Wang  
13719340555@163.com

Jordan Swensson  
jswensso@iupui.edu

Maoqing Hu  
hmq7401@163.com

Enming Cui  
cem2008@163.com

Temel Tirkes  
atirkes@iupui.edu

<sup>1</sup> Department of Radiology, Guangdong General Hospital, Guangdong Academy of Medical Sciences, No. 106 Zhong Shan Er Road, Guangzhou 510080, Guangdong, China

<sup>2</sup> Department of Radiology and Imaging Sciences, Indiana University School of Medicine, 550 N University Blvd, Indianapolis, IN 46202, USA

<sup>3</sup> Department of Radiology, Jiangmen Central Hospital, No. 23 Haibang Street, Jiangmen 529030, Guangdong, China

and fatty infiltration [6, 7]. Assessment of potential gender-specific and age-related changes of the pancreatic gland size and duct diameter may aid differentiation of normal versus disease-related changes in appearance.

Various imaging modalities, such as ultrasonography, computed tomography (CT), endoscopic ultrasound (EUS), and endoscopic retrograde cholangiopancreatography (ERCP) are useful in demonstrating morphologic changes in pancreatic aging and diseases [8–16]. However, none of these are capable of displaying the pancreatic parenchyma and duct together in a single study. Magnetic resonance imaging (MRI) with the use of MR cholangiopancreatography (MRCP) has become widely accepted as the best single non-invasive imaging modality for excellent visualization of the pancreatic gland and duct in one examination [17–21].

Although some researchers have observed the distribution of the pancreatic gland and duct size in relation to gender, age, and body habitus, the cohorts of most studies were small and their results differed from each other. Some studies showed that the gland thickness consistently decreased in relation to age, while others observed that the pancreatic head thickness gradually increased and then started decreasing after age 60. While the idea of age-dependent duct dilatation of pancreas was supported by most studies, some researchers reported the duct diameter remains fairly constant until the sixth decade [15, 16, 21–27]. Few studies stratified the age-related changes by gender [22, 25]. To our knowledge, only one study reported age-related changes of normal pancreas on MRI, with no prior studies using MRI and MRCP together to assess the pancreatic gland and duct alterations due to the aging process [21]. The purpose of our study was, in a large population without pancreatic disease who underwent MRCP, to investigate the age-associated changes of pancreatic gland size and duct diameter, and differences between males and females.

## Materials and methods

### Patient population

This HIPAA-compliant study was approved by our institutional review board, with waiver of patient informed consent. From May 2004 to May 2015, an investigator not involved in image evaluation identified 13,840 patients at our institution who underwent combined abdominal MRI and MRCP examination for suspicion of pancreatobiliary system diseases. The investigator then identified all of these patients who had normal pancreatic gland and duct presentation on MRI and MRCP images with good image quality. Patients were excluded if they had (1) history of pancreatic or liver disease (including but not limited to diabetes, pancreatitis, cystic fibrosis, and neoplasm), (2) surgery

affecting pancreas or biliary ducts, (3) abnormal hepatic or pancreatic laboratory tests (including but not limited to AST, ALT, bilirubin, and lipase), or (4) follow-up of less than 12 months. Of the qualifying patients, we selected the first 20 males and 20 females who were in each of the following age ranges: 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80–89 years of age. Therefore, the study population included 140 males and 140 females.

### MR imaging protocol

All MRI/MRCP examinations were performed with a 1.5T or 3T (Magnetom Avanto and Verio, respectively, Siemens Medical Solutions USA, Malvern PA) MRI system with standard MRI and MRCP imaging parameters using a multi-element body phased-array imaging coil. All studies were done after a fast of at least 4 h.

Thin-slice, T1- and T2-weighted images were acquired. In addition, fluid-sensitive, coronal 2D, T2-weighted, breath-hold MRCP images were obtained. Both a thin-slice 3D technique and a thick-slab sequence using a half-Fourier single-shot acquisition pulse sequence, as well as a single 40-mm-thick coronal slab, were acquired with covering the entire pancreas (Table 1).

### Measurement of pancreatic gland and duct dimensions

For each examination, age and gender were recorded and followed by removal of all patient identification information with subsequent assignment of new patient identification numbers. Two radiologists, with 17 years of experience and 15 years of experience in evaluating MR images, independently and blinded to gender and age, measured the anteroposterior (AP) size of the pancreas and the diameter of the main pancreatic duct (MPD) in the pancreatic head, body, and tail segments, using standard software tools available on our radiology PACS (Synapse, Fujifilm Medical Systems USA, Stamford CT).

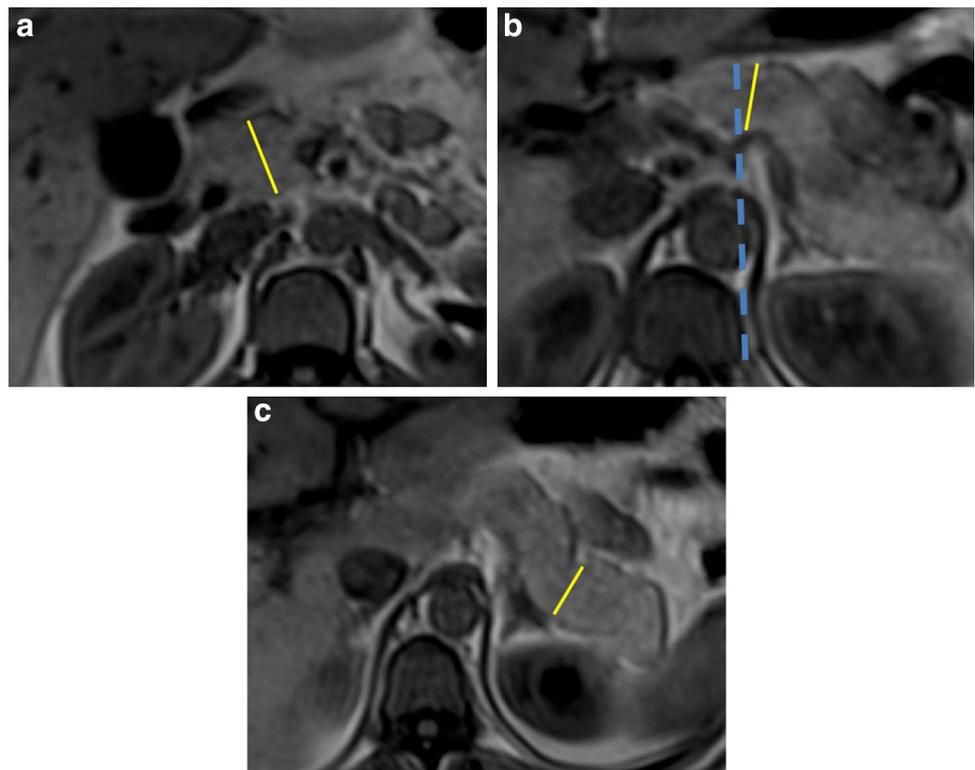
The pancreatic anterior-to-posterior (AP) size was measured perpendicular to the MPD on the axial opposed-phase T1-weighted image, and the chemical shift line at organ interface was excluded to measures (21). At the pancreatic head region, measurement was obtained at the thickest pancreatic head slice lying on the right side of the superior mesenteric vein (Fig. 1a). For the body of the pancreas, measurement was obtained at the slice of the thickest pancreatic gland or widest MPD, from the point of intersection between a vertical line along the left vertebral body margin and the dorsal margin of the pancreas to the ventral margin of the pancreas (Fig. 1b). The tail of the pancreas was measured at two alternative planes depending on the position of the tail. One plane was measured at the level of the lateral margin of

**Table 1** MRI/MRCP sequence parameters of 1.5T and 3T

Sequence	TR (m/s)		TE (m/s)		FA (°)		Slice thickness (mm)		Bandwidth (Hz)	
	1.5T	3.0T	1.5T	3.0T	1.5T	3.0T	1.5T	3.0T	1.5T	3.0T
GRE Dixon T1-W	7.53	5.52	2.38	2.45	10	9	4	5	475	500
Fast T2-W axial & coronal	1200	2000	90	96	180	150	5	5	700	780
HASTE MRCP radial slab	2100	4500	750	620	180	160	40	42	300	380
3D MRCP	4630	3060	700	700	140	95	1	1.2	350	320
VIBE pre and post contrast	5.18	4.19	2.35	1.47	10	9	2.6	4	345	350

*MRI* magnetic resonance imaging, *MRCP* MR cholangiopancreatography, *HASTE* Half-Fourier acquisition single-shot turbo spin-echo, *GRE* gradient echo, *VIBE* volumetric interpolated breath-hold examination, *TR* repetition time, *TE* echo time, *FA* flip angle

**Fig. 1** a–c Yellow arrows show the pancreatic AP measurements that were defined as the maximal pancreatic gland ventral-to-dorsal diameters on the axial in-phase T1-weighted images: **a** pancreatic head size, **b** pancreatic body size (the blue line is a vertical line along the left vertebral body margin), and **c** pancreatic tail size



the left adrenal and the other measurement was obtained at the level of the left renal hilum (Fig. 1c). The MPD diameter, which is in the center of each segment along the long axes of the head, body, and tail of the pancreas, was measured on the coronal 2D thick-slab MRCP images (Fig. 2).

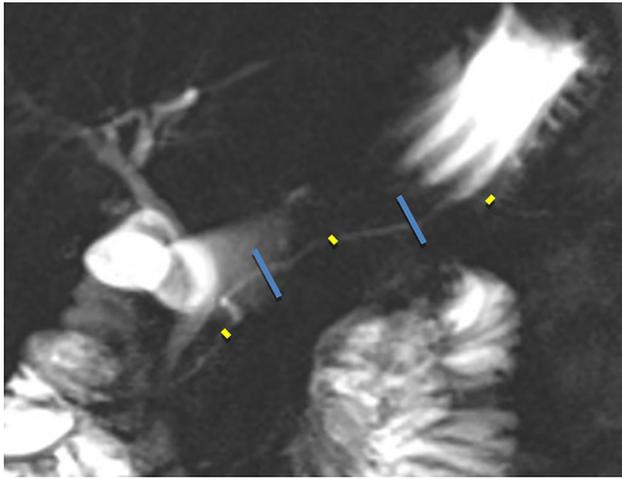
### Evaluation of the reproducibility of the pancreatic gland and duct measurements

For each portion of the pancreas, intra-class correlation coefficient (ICC) was calculated to test the agreement between the two readers. ICC can be interpreted as follows: 0–0.2 indicates poor agreement; 0.3–0.4 indicates fair agreement; 0.5–0.6 indicates moderate agreement; 0.7–0.8 indicates

strong agreement; and > 0.8 indicates almost perfect agreement [28].

### Statistical analysis

For all analyses, the mean value of the two reader measurements was used as the research data. The mean and standard deviation (SD) of the AP size and MPD diameter for each segment was calculated by gender and age. The measurement between males and females, and the group of age 20–29 with other age groups were compared, using unpaired two-tailed *t* test. 95% confidence intervals were calculated by gender, age, and gland/duct segments. Pearson correlation coefficients were used to compare



**Fig. 2** Yellow lines show the diameters of the main pancreatic duct, which were measured on the coronal thick-slab MRCP images. These sites were chosen near the center along the long axes of the head, body, and tail of the pancreas. Blue lines indicate the borders of the pancreatic segments

association between the AP size and MPD diameter for each segment. Regression model fitting (centered at the mean patient age) was performed for the AP and MPD diameters for each segment, to determine interaction of age and gender on gland size/duct diameter. Statistical analysis was performed using SPSS Statistics (version 20.0, IBM, Armonk NY), and a *p* value less than 0.05 was considered statistically significant.

## Results

280 patients (140 female) were evaluated for this study, with age mean/standard deviation of 54.0/19.9 years (range 20–88) for females, and 54.8/19.6 years (range 20–87) for males.

## Interobserver measurement of agreement

ICC between the two readers were 0.978, 0.981, and 0.985, respectively, for the measurements of pancreatic head, body, and tail gland, and 0.950 and 0.876, respectively, for the measurements of head and body duct, all of which indicated almost perfect agreement. Interobserver reproducibility value was 0.761 for measurement of tail duct, or strong agreement.

## Normal pancreatic gland size and duct diameter by gender

Reliable measurements of tail ducts could not be obtained in 7 participants due to the extremely narrow duct diameters or poor demonstration of the most distal duct portion from the MRCP images. Within our cohort, the missed data of tail duct measurements for males included 1 in the age groups of 50–59, 1 in the age groups of 70–79, and 4 in the age groups of 80–89, respectively. Similarly, the missed data of tail duct measurements for females included 1 in the age group of 50–59. Mean gland size in the pancreatic head and body was greater in males (Table 2), while mean gland size in the tail and duct diameter in all pancreatic sections did not vary between genders.

## Normal pancreatic gland size and duct diameter by age and gender

In males, the size of the pancreatic gland initially rose and then fell with age, while the diameter of the pancreatic duct increased gradually with age. In comparing to the 20–29 age group, the head of the gland at ages 40–49 and 50–59 and the body of the gland at ages 60–69 was significantly larger. All segments of the pancreatic gland in the 80–89 age group were significantly smaller than the 20–29 age group. In addition, the duct of pancreatic head in the 40–49 age group as well as the duct of pancreatic head and body in the 50–59, 60–69, and 70–79 groups were significantly larger than in the 20–29 age group, and all segments of the pancreatic duct

**Table 2** Mean/SD of measurements for each gland and duct location (mm) by gender

	Location	Male ( <i>n</i> = 140)	Female ( <i>n</i> = 140)	<i>p</i> value
Gland size (mm) Mean ± SD	Head	<b>25.00 ± 3.93</b>	<b>23.50 ± 4.10</b>	< 0.01*
	Body	<b>18.06 ± 4.29</b>	<b>16.89 ± 4.51</b>	0.03*
	Tail	17.83 ± 4.53	17.04 ± 5.34	0.19
Duct diameter (mm) Mean ± SD	Head	1.99 ± 0.50	1.99 ± 0.57	1.00
	Body	1.57 ± 0.35	1.53 ± 0.33	0.33
	Tail	1.27 ± 0.23	1.27 ± 0.24	1.00

Values in bold indicate significance

\*Significant difference of mean gland size between male and female

in the 80–89 age group were significantly larger than the 20–29 age group as well.

Generally, within our female cohort, the size of pancreatic gland decreased but the size of the pancreatic duct increased gradually with age. The tail of the pancreatic gland in the 50–59 age group and all segments of the pancreatic gland at ages 60–69, 70–79, and 80–89 were significantly atrophic as compared to the 20–29 age group. As for pancreatic duct, the body in the 30–39 age group and the all segments in the 70–79 and 80–89 age groups were significantly larger than in the 20–29 age group.

The mean duct diameter and gland size of all pancreatic segments and interval between each adjacent age group are shown in Tables 3, 4, 5, and 6. For all gender–age combinations, the largest change in gland and duct size occurred between the 70–79 and 80–89 age groups.

**Correlation among gland and duct regions**

Pearson correlation coefficients were 0.45–0.57 among gland sites and 0.53–0.73 among duct sites. Gland versus duct diameters showed weak negative correlations ( $r =$

**Table 3** Mean of gland size (mm) versus age for males ( $n = 140$ ) with  $p$  compared with age 20–29 cohort

Age	Head	Gap	$p$ Value	Body	Gap	$p$ value	Tail	Gap	$p$ Value
20–29	24.21 ± 2.90	–	–	17.33 ± 2.38	–	–	18.69 ± 3.19	–	–
30–39	26.01 ± 3.52	1.8	0.09	18.44 ± 3.55	1.11	0.25	19.12 ± 2.86	0.43	0.66
40–49	26.43 ± 1.99	0.42	0.01*	18.71 ± 3.35	0.27	0.14	18.91 ± 2.72	0.21	0.82
50–59	26.20 ± 2.92	0.23	0.04*	18.80 ± 2.80	0.09	0.08	18.61 ± 2.45	0.3	0.93
60–69	24.82 ± 2.69	1.38	0.51	18.90 ± 2.33	0.1	0.04*	17.23 ± 2.14	1.38	0.1
70–79	24.29 ± 2.41	0.53	0.93	17.75 ± 3.00	1.15	0.63	17.13 ± 3.40	0.1	0.15
80–89	21.29 ± 2.71	3	< 0.001*	13.70 ± 2.79	4.05	< 0.001*	13.33 ± 3.54	3.8	< 0.001*

Gap the interval between two adjacent groups

\*Significant difference of  $p$  compared with age 20-29 cohort,  $n = 20$  for each measurement

**Table 4** Mean of gland size (mm) versus age for females ( $n = 140$ ), with  $p$  compared with age 20–29 cohort

Age	Head	Gap	$p$ Value	Body	Gap	$p$ value	Tail	Gap	$p$ Value
20–29	25.08 ± 2.72	–	–	19.21 ± 3.32	–	–	20.38 (3.15)	–	–
30–39	25.10 ± 2.27	0.02	0.98	17.91 ± 2.60	1.3	0.18	18.95 (3.01)	1.43	0.15
40–49	23.95 ± 2.41	1.15	0.17	18.60 ± 2.28	0.69	0.5	18.53 (3.81)	0.42	0.1
50–59	24.10 ± 2.67	0.15	0.26	17.46 ± 2.91	1.14	0.08	17.36 (3.22)	1.17	< 0.001*
60–69	23.08 ± 2.80	1.02	0.03*	15.73 ± 2.25	1.73	< 0.001*	15.69 (3.50)	1.67	< 0.001*
70–79	23.42 ± 2.26	0.34	0.04*	17.02 ± 2.77	1.29	0.03*	16.74 (2.23)	1.05	< 0.001*
80–89	21.52 ± 2.87	1.9	< 0.001*	15.06 ± 2.68	1.96	< 0.001*	13.38 (3.15)	3.36	< 0.001*

Gap the interval between two adjacent groups

\*Significant difference of  $p$  compared with age 20-29 cohort,  $n = 20$  for each measurement

**Table 5** Mean of duct size (mm) versus age for males ( $n = 140$ ) with  $p$  compared with age 20–29 cohort

Age	Head	Gap	$p$ Value	Body	Gap	$p$ Value	Tail <sup>a</sup>	Gap	$p$ Value
20–29	1.74 ± 0.35	–	–	1.43 ± 0.16	–	–	1.19 ± 0.16	–	–
30–39	1.83 ± 0.17	0.09	0.31	1.47 ± 0.17	0.04	0.45	1.22 ± 0.12	0.03	0.51
40–49	1.95 ± 0.31	0.12	0.05*	1.47 ± 0.16	< 0.001	0.43	1.19 ± 0.17	0.03	1
50–59	2.02 ± 0.34	0.07	0.01*	1.59 ± 0.30	0.12	0.04*	1.29 ± 0.16	0.1	0.06
60–69	2.01 ± 0.34	0.01	0.02*	1.61 ± 0.24	0.02	0.01*	1.28 ± 0.20	0.01	0.13
70–79	2.03 ± 0.39	0.02	0.02*	1.58 ± 0.28	0.03	0.04*	1.25 ± 0.14	0.03	0.22
80–89	2.59 ± 0.40	0.56	< 0.001*	1.96 ± 0.22	0.38	< 0.001*	1.45 ± 0.27	0.2	< 0.001*

Gap: the interval between two adjacent groups

\*Significant difference of  $p$  compared with age 20-29 cohort,  $n = 20$  for each measurement unless noted

<sup>a</sup>The number of tail duct measurements was 19 in group 50–59 female, and 19, 19, 16 in groups 50–59, 70–79, and 80–89 male, respectively

**Table 6** Mean of duct size (mm) versus age for females ( $n = 140$ ), with  $p$  compared with age 20–29 cohort

Age	Head	Gap	$p$ Value	Body	Gap	$p$ Value	Tail <sup>a</sup>	Gap	$p$ Value
20–29	1.78 (0.29)	–	–	1.35 ± 0.11	–	–	1.19 ± 0.17	–	–
30–39	1.71 (0.15)	0.07	0.34	1.43 ± 0.12	0.08	0.04*	1.20 ± 0.17	0.01	0.86
40–49	1.82 (0.25)	0.11	0.64	1.50 ± 0.20	0.07	0.01*	1.21 ± 0.13	0.01	0.68
50–59	1.84 (0.25)	0.02	0.49	1.44 ± 0.22	0.06	0.12	1.29 ± 0.14	0.08	0.05*
60–69	1.94 (0.32)	0.1	0.11	1.44 ± 0.18	0	0.07	1.27 ± 0.18	0.02	0.16
70–79	2.15 (0.38)	0.21	< 0.001*	1.64 ± 0.21	0.2	< 0.001*	1.32 ± 0.13	0.05	0.01*
80–89	2.44 (0.44)	0.29	< 0.001*	1.78 ± 0.27	0.14	< 0.001*	1.41 ± 0.19	0.09	< 0.001*

Gap the interval between two adjacent groups

\*Significant difference of  $p$  compared with age 20–29 cohort,  $n = 20$  for each measurement unless noted

<sup>a</sup>The number of tail duct measurements was 19 in group 50–59 female, and 19, 19, 16 in groups 50–59, 70–79, and 80–89 male, respectively

0.11–0.31) (Table 7), reflecting the effects of gland atrophy and ductal diameter increase described previously.

### The internal relation between age and the size of pancreatic gland and diameter of duct

Mean gland sizes/duct diameters with 95% confidence intervals are presented in Fig. 3a–d. Regression model fitting (centered at age 54 years) showed that as the gland size decreased the duct diameter increased with age at all sites, and significant age–gender interaction occurred in the gland head and body.

## Discussion

Pancreatic gland endocrine and exocrine function plays a significant role in the digestive system, and undergoes atrophy as expected with aging; however, acute and chronic diseases of the pancreas can also lead to gland atrophy and reduction in function. It is therefore important to know the normal values of pancreatic gland and main pancreatic duct measurements to help differentiate

age-related changes with pathologic changes. However, not much attention has been paid by imagers to the natural, physiological changes of the pancreatic gland and duct diameters with age. We studied a large cohort to quantitatively evaluate age- and gender-specific changes of the pancreatic gland and duct dimensions using MRI/MRCP in an adult population.

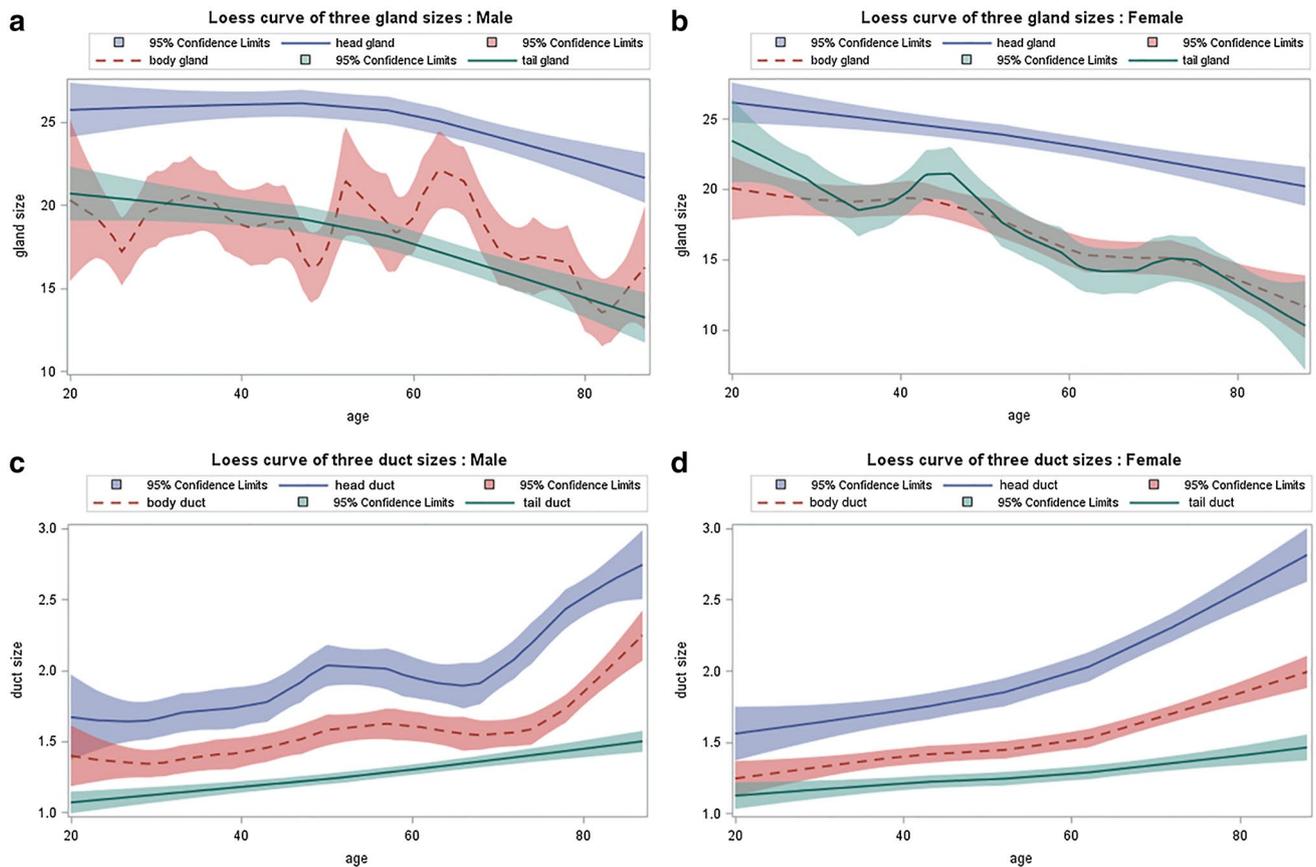
Our results showed that there was almost perfect interobserver reproducibility of measurements for pancreatic gland thickness, and head and body duct diameters, and strong agreement for the tail duct diameter. The lower agreement of measurement of the tail duct can be attributed to the generally smaller diameter of the duct at the tail, which makes measurements less precise.

We found that the AP size of the pancreatic gland is generally smaller in females than in males, especially in the pancreatic head and body ( $p < 0.05$ ). Our finding was in concordance with previous similar studies [22, 29]. The gender-specific differences of pancreatic gland size are probably due to the stature differences between females and males. Interestingly, we did not find such a difference in the pancreatic duct diameter, which was in agreement with a study based on ERCP measurements [27].

**Table 7** Pearson correlation coefficients among gland and duct regions

Group	Gland size			Duct diameter		
	Head	Body	Tail	Head	Body	Tail
Gland size						
Head	–	0.53	0.45	– 0.17	– 0.18	– 0.11
Body	–	–	0.57	– 0.24	– 0.23	– 0.15
Tail	–	–	–	– 0.31	– 0.27	– 0.18
Duct diameter						
Head	–	–	–	–	0.73	0.53
Body	–	–	–	–	–	0.61
Tail	–	–	–	–	–	–

All  $p$  values are significant. Negative coefficients represent weak negative correlation between decreasing gland size and increasing duct diameter seen with increase in age



**Fig. 3** a–d Plots of pancreatic gland sizes and duct diameters: **a** Loess curve of three gland sizes in males, **b** Loess curve of three gland sizes in females, **c** Loess curve of three duct diameters in males, and **d** Loess curve of three duct diameters in females

In male patients, a mild increase in size of the pancreatic gland over several decades gave way to a marked decrease in pancreatic gland size and marked increase in pancreatic duct diameter after age 80. In clinical radiologic practice, there is often a question of at what age to expect senescent atrophy of the pancreas. These results suggest that substantial decreases in gland size before the age of 80 in male patients are not likely to be age-related, which may prompt the radiologist to participate in a more complete evaluation for pathologic causes of gland atrophy. Female patients showed a similar abrupt decrease in gland size after the age of 80, but without an increase in gland size in the previous decades, which makes this finding somewhat less useful in clinical practice. The underlying trigger mechanism for rapid morphologic change in the pancreas around the seventh to eighth decade remains unknown but its elucidation might improve understanding of the aging mechanism of other solid organs.

Some studies of age-related changes in pancreatic structure have shown contradictory findings to ours. For example, Gilbeau et al. found that the pancreas became increasingly lobulated with age (especially in diabetics), but the

pancreas in non-diabetic subjects demonstrated no correlation between size and age [13]. Syed et al. using CT exams to study pancreatic volume and size found that although increasing age was associated with a moderate decrease in pancreatic volume and in the size of pancreatic body and tail, the anteroposterior size of the head increased with age up to 71 years [25]. Rajan et al. undertaking a prospective endoscopic ultrasound study of age-related changes in the pancreas found that the median pancreatic gland width had a tendency to increase with age [16]. In the study of Sato et al., MR imaging was used to evaluate the age-related changes in normal adult pancreas; the depiction of the MPD was graded using a fat-saturated T2-weighted image, but no significant correlation was observed between aging and the depiction of the MPD [21]. The major reason for these perceived discrepancies is largely related to the different imaging techniques, such as CT or EUS, used in previous studies [13, 16, 25]. In addition, different age and gender distributions, and anthropometric characteristics of subjects among the studies may attribute for the differences.

Our data found that the correlations between age and duct diameter in different regions were more obvious than that

between age and gland size, which may indicate that the changes of each part of the main pancreatic duct are more synchronous with age than those of the pancreatic gland. This finding suggests the pancreatic duct may be more valuable for clinical assessment of pancreatic disease, but further study is still needed.

It remains unknown whether there is a relationship between the pancreatic gland size and ductal diameter. However, a very weak negative correlation was found in our study. It suggests that the two separate physiologic processes that account for the changes in parenchymal size and ductal diameter may occur asynchronously. It has been well documented that decrease of pancreatic size is secondary to fat infiltration and fibrosis of parenchyma [7], while pancreatic duct dilation results from epithelial hyperplasia, peri-ductular fibrosis, and cystic widening [6] rather than the consequence of gland shrinkage. This finding also suggests that the dilation of pancreatic duct should not always be expected when pancreatic atrophy has occurred and vice versa.

A limitation of our study is that physiological conditions such as height and weight may influence pancreatic size, but were not evaluated in this study. This should be taken into account together with age and gender in future studies. Therefore, a prospective study of MR/MRCP obtained in healthy normal subjects would be optimal. Nevertheless, the present study is the largest age- and gender-matched study using MRI/MRCP published to date.

## Conclusion

In conclusion, we find that MRI with the use of MRCP can demonstrate the size of the pancreatic gland and duct with high reproducibility. There are gender differences in gland size of pancreatic head and body. Pancreatic gland size increases until the sixth decade followed by decrease in males, while continuous decrease occurs with age in females. There is a more dramatic decrease in gland size in male patients after the age of 80, suggesting that substantial gland atrophy prior to this point is more likely to be related to non-senescent causes. The duct diameter increases with age in both males and females.

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