Original Article

A Gross Morphometrical and Morphological Study of Adult Human Pancreas from Autopsied Bodies and its Age-Related Changes

Revathi Murugesan[1], Renuka Krishnapillai[2], Latha Sreedhar Lekshmi Sreedhar[3]

[1]Assistant Professor, Department of Anatomy, Karpagam faculty of medical sciences and research, Coimbatore, Tamil Nadu, India. [2]Former Professor and Head, Department of Anatomy, Government medical college, Thiruvananthapuram, Kerala, India. [3]Professor, Department of Anatomy, Travancore medical college, Kollam, Kerala, India.

Abstract

Background: The pancreas is the largest of the digestive glands and performs both exocrine and endocrine functions. The incidence of type 2 diabetes, pancreatitis, pancreatic cancer, pancreatic exocrine insufficiency and endocrine tumors increases with age. Hence the objectives of this research were to observe the gross morphology and morphometry of pancreas and their age-related changes which is necessary for differentiating the above disease conditions and the normal ageing process of pancreas. **Materials and Methods:** Descriptive cross-sectional research was undertaken on 50 normal adult human pancreases from autopsied bodies who were above 25 years of age. The pancreases were collected from five different age groups with ten samples each. The gross measurements and shape of the pancreas were noted during the autopsy. **Results:** The mean length and weight of the pancreases were 19.2±2cm and 89.3±28.8gms respectively. The mean width of head, neck, body and tail were 5.42±0.81, 3.80±0.69, 4.45±0.59 and 3.18±0.61 respectively. Four different shapes of pancreas were observed namely oblique, transverse, sigmoid and inverted among which the oblique shape was more common. The age changes in the shape, length and width of the head, body and tail of the pancreas were not statistically significant but there was significant age changes found in the width of the tail and weight of the pancreas. **Conclusion:** This knowledge will help in detailed understanding of the structure of pancreas in different age groups and also to comprehend the pathogenesis and management of pancreatic diseases which may also serve as a guide for further clinical research on pancreas.

Keywords: Pancreas; gross morphology; age related changes.

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Introduction

At around 100 AD, Rufus of Ephesus coined the term ‘PANCREAS’, which derived its name from two Greek words ‘pan’ and ‘kreas’ meaning ‘all’ and ‘flesh’ respectively.[1,2] The pancreas is creamy pink in colour with a lobulated smooth surface and soft to firm consistency. It lies within the curve of the first three parts of duodenum and extends behind the stomach up to the hilum of the spleen retroperitoneally.[3] The pancreas extends from the right side of second lumbar vertebra, transversely to the left and slightly cranially, to the hilum of the spleen at the twelfth thoracic vertebral level.[2] In adults, the pancreas is about 12-15cm long and weighs about 80 gms.[1,3] The average volume of the pancreas in adult is about 70-80cm^3 with a range of 40-170cm^3. The pancreas can be divided into head with uncinate process, neck, body and tail based on its anatomical relations. The uncinate process is a hook like projection from the inferior left part of the head.[3] Among the digestive glands, the pancreas is one of the largest. It consists of both exocrine and endocrine components. The major part of the gland is exocrine in function.[3,4]

Due to the increasing incidence of diabetes mellitus and other disorders like pancreatic tumors and pancreatitis, pancreas remains an organ on which much research is going on. The recent reports released from the International Federation of Diabetics in 2025 showed that in the adult population, in age group of 20-79 years, 589 million adults in global population have diabetes. In India, the prevalence of Diabetes in adult population is about 10.5%.[5]

The majority of human body tissues are negatively influenced by the ageing process.[6] A comprehensive knowledge of pancreatic structure with age is necessary for appropriate treatment of its diseases especially the surgical conditions. Although the pancreas plays a central role in the pathogenesis of type 2 Diabetes, the gross anatomy of human pancreas is least studied because of its inaccessible anatomical position.[1] The knowledge of gross and microscopic structure of pancreas is largely obtained from the animal studies. The studies on human pancreatic structure are relatively less.[2] Hence the focus of this study was

Address for correspondence: Dr. Revathi Murugesan, Assistant Professor, Department of Anatomy, Karpagam faculty of medical sciences and research, Coimbatore, Tamil Nadu, India
E-mail: revu.sellakkannu92@gmail.com

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to obtain a detailed knowledge of the gross morphometry and morphology with possible age-related changes in the adult human pancreas. This insight could provide a better understanding of the difference between the true disease conditions and the normal ageing process of pancreas.

Materials and Methods

After obtaining Institutional ethical committee consent, a descriptive study of cross-sectional design was adopted to conduct research on normal adult human pancreases obtained from the autopsy cases in the Department of Forensic medicine of Government medical college, Thiruvanathapuram, Kerala, India for a period of one and a half years. Normal pancreatic tissues from the deceased of both sexes who were above 25 years of age were taken for the study after obtaining consent from the relatives of the deceased. Since the pancreas would continue to grow up to 25 years of age, the samples were taken from the deceased who were past 25 years.[7] Pancreas from the deceased with abdominal trauma, history/finding of pancreatic diseases and anomalies were excluded from the study.[8] Non probability sampling technique was applied to obtain the required sample size. The age, sex, height, weight and cause of death of the individual were noted. A total of 50 number of pancreases were collected and studied in this research. The samples were divided into 5 different age groups namely 26-35 years, 36-45 years, 46-55 years, 56-65 years and > 66 years age groups. 10 samples were collected in each group.[9] The morphological and morphometrical parameters observed were shape of pancreas, presence and absence of uncinate process, length, width and weight of the pancreas.

The pancreas was removed from the body along with duodenum during the autopsy. It was separated from the surrounding structures and the pancreas specimen was gently washed with normal saline. The pancreas was observed for different shapes such as oblique, sigmoid, L shaped, horseshoe, transverse and inverted V.[10] The number of each shape and their distribution in each age group were noted. Then the length and width were measured using an inelastic cotton thread and a vernier caliper. The length was measured from the duodenal margin of the head of pancreas at the point of maximum convexity to the tip of the tail. The width was measured for the head, neck, body and tail regions. Multiple measurements from the upper limit to lower limit of the particular region was noted and the maximum value was taken for the width.[8] The weight was measured using an electronic weighing balance with ±0.1g sensitivity.[7] Photographs of relevant findings with high resolution camera were taken. Quantitative variables were analysed using mean and standard deviation and the statistical test of significance used was Analysis of variance (ANOVA). Categorical variables were analysed using proportion and the statistical test of significance used was Chi square test. The p value < 0.05 was considered statistically significant.

Results

The age range seen in this study was 26-82 years. Majority of the individuals in the study were males with 88%(n=44). Only 12% females(n=6) were present. The majority of specimens were from males among all age groups and there were no females in the 46-55 years and >66 years age groups. The total mean height of the individuals was 164.2±7.3cm and the range was 150-178cm.There was no significant height difference between the groups (P value=0.199). The total mean weight of the individuals in this study was 62.4±8.7kg. The maximum mean weight (68.3±6.5kg) was seen in 36-45 years age group and the minimum mean weight (56.9±11.8kg) in >66 years age group. The range of weight seen in the study subjects was 32-83kg. There was statistically significant weight difference between the groups (P value=0.016). The total mean body mass index was 23.2±3.2kg/m^2 and the range was 13.49- 31.70kg/m^2. The differences in the BMI were not statistically significant (P value=0.112).

The mean length, width and weight of the pancreas among different age groups are given in Table 1.

The overall mean length of the pancreas was 19.2±2cm. The maximum length of pancreas was 24.2cm in a 50 years old male and the minimum length was 15.2cm in a 73 years old male. The lowest mean length (18.9±1.6cm) was seen in 36-45 years age group. The age changes in the length of the pancreas were not statistically significant (P value=0.978).

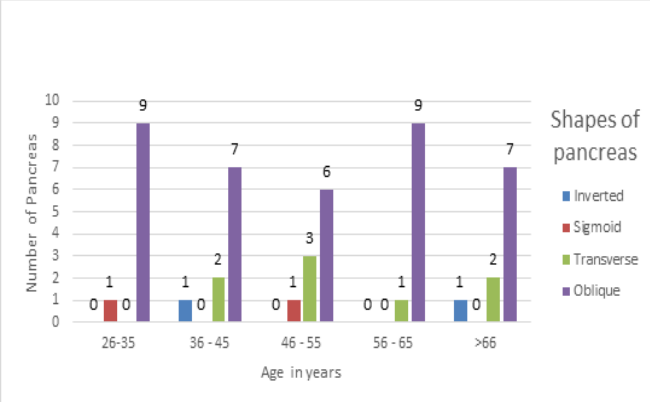
The range of width of pancreas at its head, neck, body and tail were 4-7.5cm, 2.4-5.2cm, 3-5.5cm and 2-4.5cm respectively. There were no significant age changes in the width of head (P value=0.934), neck (P value=0.388) and body (P value=0.136) regions, but tail region showed significant changes (P value=0.016). The width was maximum in the 36-45 years age group in all the regions.

The overall mean weight of the pancreas was 89.3±28.8gms and the range was 40-150gms. The highest mean weight (117.5±26.8gms) was seen in 36-45 years age group and the lowest mean weight (71±20.7gms) was seen in 26-35 years age group. The weight increased up to 36-45 years age group and then decreased gradually except in the 46-55 years age group. Thus, there were significant age changes found in the weight of the pancreas (P value=0.003). The weight of pancreas was found to have weak positive correlation with the body mass index. But the correlation coefficient between these two parameters was not statistically significant (P value =0.140).

4 different shapes were observed in the pancreas collected in this research [Figures 1-4]. They were oblique(n=38), transverse (n=8), sigmoid (n=2) and inverted V(n=2). Among these shapes, pancreas with oblique shape was maximum (76%) and sigmoid and inverted V were minimum (4% each). The shape distribution among the five age groups is given in graph 1. In all the age groups, oblique shape of the pancreas was more common. No transverse shape was seen in the 26-35 years age group. Sigmoid shape was seen in 26-35 years and 46-55 years age groups. Inverted V shape was seen in the 36-45 years and >66 years age groups. There was no statistical significance between the age and the shape of pancreas (P value =0.598). Five pancreas (10%) had no uncinate process. Among the rest, six pancreas showed fusion of the head and the uncinate process. The absence of uncinate process was seen in only two age groups namely 36-45 years and 46-55 years.

Table 1: Mean length, width and weight of the pancreas among different age groups

Age	Length of pancreas(cm)		Width of head(cm)		Width of neck(cm)		Width of body(cm)		Width of tail(cm)		Weight of pancreas(gm)	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
26-35	19.1	2.2	5.33	1.17	3.62	0.79	4.47	0.80	3.07	0.67	71.5	20.7
36 - 45	18.9	1.6	5.59	0.54	4.10	0.50	4.84	0.48	3.60	0.45	117.5	26.8
46 - 55	19.4	1.9	5.32	0.76	3.66	0.72	4.32	0.50	2.71	0.64	79.5	18.0
56 - 65	19.4	1.6	5.50	0.64	3.97	0.79	4.18	0.39	3.20	0.56	90.0	25.2
>66	19.3	2.9	5.35	0.94	3.63	0.57	4.44	0.59	3.30	0.43	88.0	32.7
Total	19.2	2.0	5.42	0.81	3.80	0.69	4.45	0.59	3.18	0.61	89.3	28.8
P value	0.978		0.934		0.388		0.136		0.016		0.003	



Graph 1: Bar diagram showing shape distribution in each age group

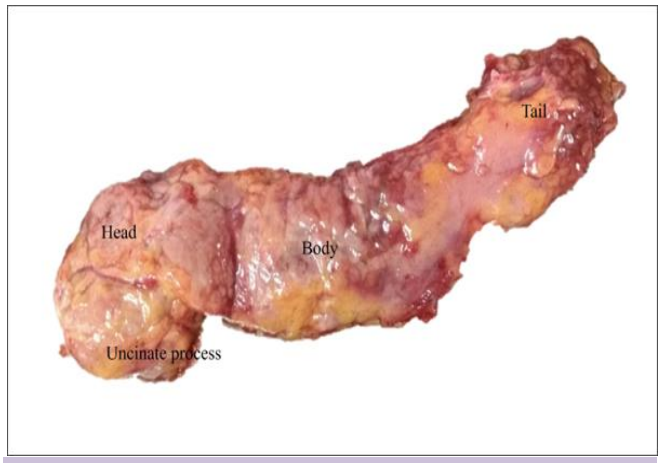


Figure 1: Oblique shape of pancreas

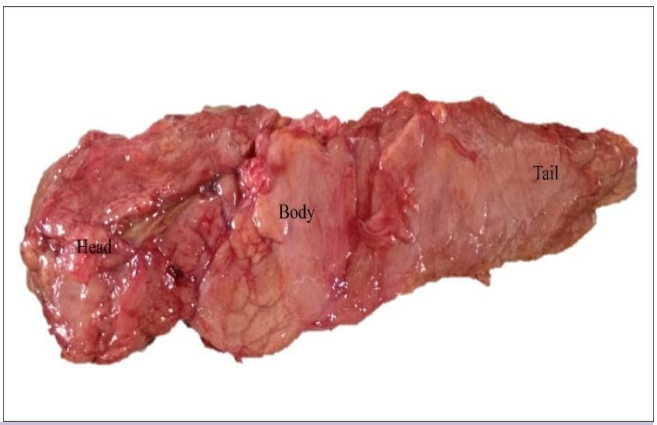


Figure 2: Transverse shape of pancreas with no uncinate process

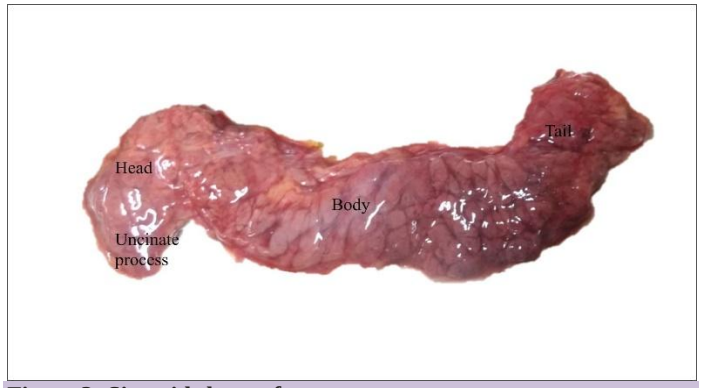


Figure 3: Sigmoid shape of pancreas

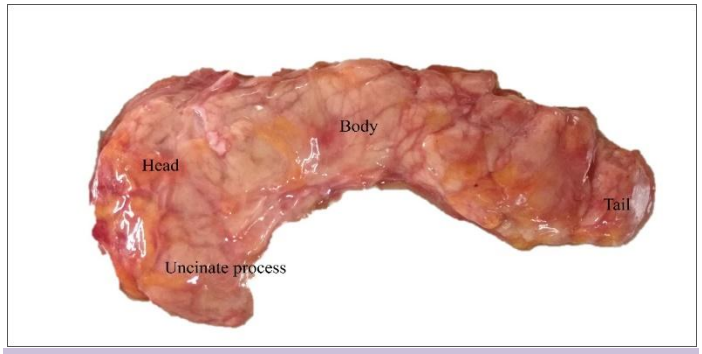


Figure 4: Inverted V shape of pancreas

Discussion

Ageing begins at the molecular level which in turn affects the number and structure of the cells, gross appearance of the tissues and the external form of the individual. The incidence and prevalence of diabetes, acute pancreatitis, pancreatic exocrine insufficiency, pancreatic cancer and endocrine tumors increase with age.[11,12] There is also evidence for progressive decrease in pancreatic volume with age and concurrent occurrence of steatosis. The elderly pancreas resembles the changes of chronic pancreatitis in its early stage.[13]

Pancreatic surgery is the surgery of 20th century. Before 1900 A.D, little was known about the pancreatic structure and function. Surgeons feared to approach the organ because of its given dangerous irritability and difficult to access location. The key anatomical discoveries, physiological research, expansion in clinical and pathophysiological knowledge, developments in endocrinology and advent of antisepsis, anaesthesia and improved homeostasis have led to the evolution of pancreatic surgery to the recent level.[2] Various newer surgical procedures and whole pancreatic transplantations are being attempted

nowadays for the treatment of pancreatic diseases and a detailed knowledge of the pancreatic structure can yield better results.

In the present study, the mean length of the pancreas was 19.2±2cm in the people with age ranging from 26- 82 years. The highest mean length was seen in 46-55 years and 56-65 years age groups and the lowest mean length (18.9±1.6cm) was seen in 36-45 years age group which was in accordance with the study conducted by Ahmed Firoz.[14] Sulochana S and Sivagami T showed that the length of the pancreas was in the range of 9.2-24cm with a mean of 16.38±2.38cm in the age group of 23-61 years.[8] The range of length obtained in the present study was higher compared to the range (12-15cm) reported by Bailey and Love,[1] Gray,[3] and Last.[15] Ahmed H. Hussein et al in his study on 20 human pancreases showed that the length was maximum at 31-40 years and minimum at 61-70 years of age on morphometric analysis. He also did an ultrasonic examination of length of pancreas in different age groups which also yielded similar results as gross morphometric examination.[9] Shabnam Mohammadi et al noticed in Iranian population that the mean pancreatic length was 15.22±5.09cm in 312 cadaveric pancreas with age ranging from 0-99years. The minimum mean was seen in the age group of 90-99 years.[16] Baneswar Baro et al observed that among the 103 human pancreases from people of age ranging from 13-78 years in the Assamese population, the total mean length was 13.94 ±1.39cm. The mean length increased upto 40 years and thereafter remained almost the same.[17]

There were no significant age changes in the width of head, neck and body regions, but the tail region showed significant changes in our research. The width was maximum in the 36-45 years age group in all the regions. The mean width obtained in the present study was higher than that obtained in the study conducted by Sulochana S et al,[8] and Shabnam Mohammadi et al.[16]

The mean weight of the pancreas in the present study was 89.3±28.8gm and the range was 40-150gm. The weight increased up to 36-45 years age group and then decreased with increasing age. The weight of pancreas was not related with the body mass index. Stamm BH found that the pancreatic weight decreased considerably with advancing age. In subjects with age less than 40 years, the mean pancreatic weight was 112.3gm but in those subjects above 80 years, it decreased to 68.2gm.[18] de la Grandmaison et al showed that the pancreatic weight decreased with age. It showed significant changes with alteration in the body mass index.[19] Ardeshir Sheikhazadi et al reported that the weight of pancreas reached the maximum at 35-44 years in males and 45-54 years in females and then slowly decreased with senility. The pancreatic weight had a strong correlation with body mass index in females.[20] Ahmed Firoz observed that the mean weight was maximum in 41-65years group in both sexes.[14] Veli Caglar et al reported that the weight of the pancreas was in the range of 41 to 174gm in the age group of 25-88 years.[7] Puttaswamy described that pancreas attained maximum weight at 40-50 years and then started decreasing.[21] Ahmed H.Hussein et al showed that the weight of pancreas was maximum at 31-40 years and minimum at 61-70 years of age on morphometric analysis.[9] Baneswar Baro et al observed that the total mean weight was 78.27 ± 18.29gm ranging from 13.64gm-131.84gm.[17] KS Basnet et al had concluded in their study that both the mean length and weight decreases in >40 years age group.[22] The findings of the present study were in accordance with most of the above discussed studies. Genetic and dietary factors may contribute to the differences in the dimensions and weight of the pancreas from different demographic regions.[22,23]

We noticed in our study that pancreas with oblique shape was observed maximum (76%) and sigmoid and inverted V were minimum (4% each). Oblique shape was more common in all the age groups. L shape and horseshoe shapes were not observed in any age group. Sulochana S et al observed three different shapes of pancreas namely oblique (87%), inverted V (9%) and sigmoid (4%).[8] Kreel and Sandin observed six different shapes of pancreas namely oblique (37%), sigmoid (27%), L shaped (27%), horseshoe (7%), transverse (2%) and inverted V (1%) shaped in the order of decreasing frequency and age factor had no influence over the shape.[10] In all the previous studies, oblique shape was more common as seen in our study.

Limitations

In the current research, because of the time and resource constraints, most of the autopsy cases available for the sample collection were males and hence, gender wise changes could not be made out. The sample population of the current study belonged to Thiruvanathapuram, Kerala. Thus, influence of genetic, environmental, dietary and demographic factors on the morphology and morphometry of pancreas could be understood better with conducting studies in different regions of the country.

Conclusion

The age changes in width of the tail and weight of the pancreas were statistically significant. Pancreas with oblique shape was more common. 5 pancreases had no uncinate process and 6 pancreases showed fusion of the head and the uncinate process. Thus, the knowledge obtained from this study on the age-related gross changes in pancreas helps in better understanding of the normal ageing process occurring in pancreas. This study also helps in expanding our knowledge on the gross structure of pancreas, in translation of this information into research and clinical practice, in better management of the pancreatic diseases and in serving as a guide for those who attempt to do further research on the age changes of pancreas.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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