Original Article

Histological Variation in the Number and Diameter of the Postmortem Human Pancreatic Islets in Relation to Age and Sex: Insight from North East Bangladesh

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Abstract

Background: Disease pattern as well as diagnostic and treatment options may be helped by examining the number and diameter of Islets of human pancreas, as the change with age. It seems that there is a research vacuum in this area and demands more studies, including gross anatomical studies, with data available in Bangladesh.

Objective: To find out the histological variations of post mortem human pancreas in relation to age and sex of north east region of Bangladesh.

Methods: Fifty human postmortem pancreases were selected. The inclusion criteria was dead bodies autopsied within 36 hours of death; while considerable signs of decomposition, decomposed dead body, dead body autopsied exceeds 36 hours after death, presence of gross pancreatic disease and poisoning cases were excluded. The obtained specimens of pancreas were classified according to the age and sex. Simultaneously, the different parts of the pancreas (head, neck, body and tail) were separated. Then each part of the gland was placed in a tray and sectioned transversely. From these slices, small pieces of tissue were taken for histological procedure. Then the tissues were processed and stained with haematoxylin and Eosin (H&E) stain. The slides were examined under microscope in low and high magnification. Number of the Islets per mm^2 area and the average transvertical diameter of the Islets of Langerhans were measured with ocular micrometer.

Results: The mean number of Islets (per mm^2) of the pancreas was 1.91 (SD±0.81) and diameter of Islets of the pancreas was 153.44µm (SD±7.22). The mean number of Islets (per mm^2) was 2.05 (SD±0.69); 2.31 (SD±0.96) and 1.38 (SD±0.55) in the age group of 5 to 20 years, 21 to 40 years and years 41 to 64 years respectively (p=0.124). The mean number of Islets (per mm^2) was 1.78 (SD±0.71) in male and 2.08 (SD±0.94) in female (p=0.449). The mean diameter of Islets was 151.0 µm (SD±5.9); 156.7 µm (SD±10.3) and 152.7 µm (SD±4.1) in the age group of 5 to 20 years, 21 to 40 years and years 41 to 64 years respectively (p=0.401). The mean diameter of Islets was 158.7µm (SD±5.3) in male and 146.9µm (SD±1.36) in female (p<0.01). A negative correlation (non-significant) was observed between age and number of Islets per mm^2 (p=0.506). A positive correlation (non-significant) was observed between age and diameter of Islets (p=0.861).

Conclusion: Age related changes were found in the diameter of pancreatic Islets. Most of the pancreatic disease can be managed with conservation of pancreas by invasive and non-invasive method. Detail knowledge on pancreatic Islets will help the physician to manage pancreatic disease.

Keywords: Pancreas, Islets, Cadaver, Ocular micrometer.

Introduction

The pancreas, an essential organ with dual endocrine and exocrine functions, exhibits distinct anatomical features such as its salmon-pink color, lobulated smooth surface, and division into head, neck, body, and tail segments. Aging results in a progressive thinning and atrophy of the pancreas, impacting its appearance on imaging. Positioned adjacent to the duodenum and spleen, the pancreas plays a critical role in digestion.[1] Pancreatic ducts are essential conduits for digestive enzymes with variations in ductal anatomy observed. Arterial supply primarily derives from the splenic artery, forming complex networks throughout the gland. Venous drainage connects to the hepatic portal vein via pancreatic veins. Lymphatic vessels follow vascular routes and drain into specific lymph nodes.[2]

Nerve supply, including sympathetic and parasympathetic components, regulates exocrine pancreas secretory functions. Understanding the pancreas's embryonic origin, fusion of dorsal and ventral buds and ductal development is crucial. Variations in ductal fusion occur in a minority of cases.[3]

The pancreas also houses Islets that produce insulin, glucagon and somatostatin. These endocrine functions begin during fetal development. Studies have reported variations in pancreatic dimensions and duct openings.[4] Considering the limited data on ancreas histology in Bangladesh, this study aims to investigate histological variations in postmortem human pancreases among Bangladeshi individuals. This research

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is especially relevant in the context of recent advancements in pancreatic surgery, where an understanding of normal variants and anomalies can have significant clinical implications.[5]

Materials and Methods

A cross-sectional descriptive study was conducted using 50 human postmortem pancreas specimens. These specimens were obtained from unclaimed deceased individuals who underwent autopsy procedures at the Department of Forensic Medicine, Sylhet M A G Osmani Medical College from July 2012 to July 2013. The inclusion and exclusion criteria for the study were strictly adhered to.

Human pancreases were collected exclusively from cadavers that met the study criteria. Only fresh specimens from deceased individuals autopsied within 36 hours of death were considered. Any specimens showing signs of decomposition, those from individuals autopsied more than 36 hours after death, cases with gross pancreatic diseases, or cases involving poisoning were excluded from the study.

Each pancreas specimen was marked with a unique code number for individual identification. After removal from the body, unwanted tissues were carefully cleared and the specimens were gently washed in distilled water. Subsequently, the specimens were fixed in 10% formal saline solution.[6]

The collected specimens were divided into three age groups: Group A (5-20 years), Group B (21- 40 years), and Group C (41-65 years). Furthermore, each group was subdivided based on sex. Small tissue pieces were taken from various parts of each pancreas specimen and preserved in 10% formal saline solution. The collected tissue samples underwent standard histological procedures. Tissue slides were stained using Haematoxylin and Eosin (H&E) stain.

Slides were examined under a microscope at both low and high magnifications. The number of Islets per square millimeter and the average transvertical diameter of the Islets of Langerhans were measured. Islet number measurements were conducted on six distinct fields from each slide, totaling 36 fields examined across six randomly chosen slides within each age and sex group.

A special counting circle device was employed, consisting of a 5mm diameter black circular outline printed on a transparent plastic sheet that fit into the microscope eyepiece. Counting was performed within this circle, rather than across the entire microscopic field. The counts from the six different fields on each slide were averaged and then converted into the number per square millimeter using a stage ocular micrometer.

The transvertical diameter of each islet was measured using both a stage micrometer and an ocular micrometer. The stage micrometer had a straight line that was one millimeter in length, divided into 100 small divisions, with each small division measuring 0.01mm. The ocular micrometer was calibrated with similar small divisions (Figure-5&6).

Data analysis was carried out manually and using the SPSS v21.Quantitative data were expressed as mean and standard deviation and comparisons were made using unpaired "t" tests or one-way ANOVA tests. Qualitative data were presented as frequency and percentage. Regression analysis was conducted to determine correlations between different variables. A probability value (p) of less than 0.05 was considered statistically significant. The research protocol received prior approval from the Ethical Committee of Sylhet M A G Osmani Medical College, Sylhet ensuring that ethical guidelines and standards were adhered to throughout the study.

Results

In the present study, a total of 50 human postmortem pancreases were analyzed. These pancreases were examined to determine the transvertical diameter of the Islets and the number of Islets in each section per mm^2 area. The age of the cadavers ranged from lowest 7 years to highest 64 years, with a mean age of 30.7 years (SD±16.6). The distribution of cadavers by age group was as follows: age group-A (5-20 years) comprised 18 (36.0%) cases, age group-B (21-40 years) comprised 17(34.0%) cases, and age group-C (41-64 years) comprised 15(30.0%) cases (Figure-1).

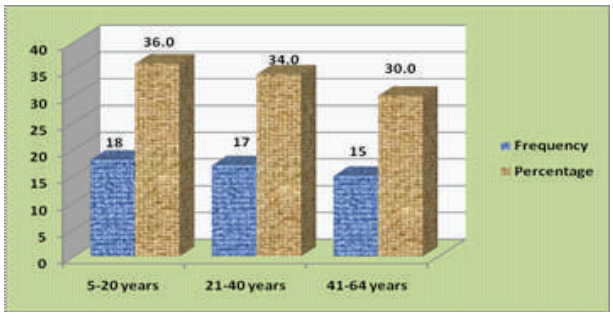

Figure-1: Distribution of the cadaver by age group (n=50)

Out of the 50 cases, 31(62.0%) were male, and 19(38.0%) were female, resulting in a male-to-female ratio of 1.63:1. The distribution of cadavers by sex is displayed in Figure-2.

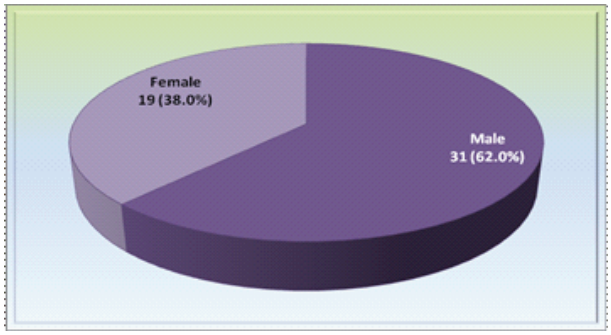

Figure-2: Distribution of the cadaver by sex (n=50)

The number of Islets (per mm^2) in the pancreas ranged from 0.78 to 3.17, with a mean of 1.91 (SD±0.81). The distribution of the number of Islets (per mm^2) in the pancreas is presented in Table-I. The diameter of Islets in the pancreas ranged from 144.0 to 167.0µm, with a mean of 153.44 µm (SD±7.22). The distribution of the diameter of Islets in the pancreas is also shown in Table-I.

Table-I: Distribution of histological parameter of pancreas (n=18)

Histological parameter	Range	Mean	SD
Number of islets (per mm^2)	0.78-3.17	1.91	0.81
Diameter of Islets (µm)	144.0-167.0	153.44	7.22

The mean number of Islets (per mm^2) was 2.05 (SD±0.69) (range 1.19-3.17) in the age group of 5 to 20 years (group-A); 2.31 (SD±0.96) (range 0.78-3.17) in the age group of 21 to 40 years (group-B) and 1.38 (SD±0.55) (range 0.78-2.39) in the age group of 41 to 64 years (group-C). The difference among the groups was not statistically significant (F=2.408; p=0.124). Distribution number of Islets (per mm^2) in pancreas by age group was shown in Table-II.

Table-II: Distribution of number of Islets (per mm^2) in pancreas by age group

Age group	Number of islets (per mm^2)		
	Range	Mean	SD
Group-A (n=6)	1.19-3.17	2.05	± 0.69
Group-B (n=6)	0.78-3.17	2.31	± 0.96
Group-C (n=6)	0.78-2.39	1.38	± 0.55
P-value		p=0.124	

Group-A: 5 to 20 years; Group-B: 21 to 40 years; Group-A: 41 to 64 years.
**One way ANOVA test was applied to analyzed the data.*

The mean number of Islets (per mm^2) was 1.78 (SD±0.71) (range 0.78-3.17) in male and 2.08 (SD±0.94) (range 0.78-3.17) in female. The difference was not statistically significant (t=-0.775; p=0.449). Distribution number of Islets (per mm^2) in pancreas by sex was shown in Table-III.

Table-III: Distribution of number of islets (per mm^2) in pancreas by sex group

Sex	Number of islets (per mm^2)		
	Range	Mean	SD
Male (n=10)	0.78-3.17	1.78	± 0.71
Female (n=8)	0.78-3.17	2.08	± 0.94
*p- value		p=0.449	

**Unpaired t test was applied to analyzed the data.*

The mean diameter of Islets was 151.0 µm (SD ± 5.9) (range 144.0-159.0 µm) in the age group of 5 to 20 years; 156.7µm (SD±10.3) (range 146.0-167.0µm) in the age group of 21 to 40 years and 152.7µm (SD±4.1) (range 147.0-156.0µm) in the age group of 41 to 64 years. The difference among the groups was not statistically significant (F=0.931; p=0.401). Distribution of diameter of Islets by age group by age group was shown in Table-IV.

Table-IV: Distribution of diameter of Islets by age group

Age group	Number of islets (per mm^2)		
	Range	Mean	SD
Group-A (n=6)	144.0-159.0	151.0	± 5.9
Group-B (n=6)	146.0-167.0	156.7	± 10.3
Group-C (n=6)	147.0-156.0	152.7	± 4.1
*p-value		p=0.401	

Group-A: 5 to 20 years; Group-B: 21 to 40 years; Group-A: 41 to 64 years.
**One way ANOVA test was applied to analyzed the data.*

TThe mean diameter of Islets was 158.7µm (SD±5.3) (range 153.0-167.0µm) in male and 146.9µm (SD±1.36) (range 144.0-148.0µm) in female. The difference was statistically significant (t=6.126; p<0.01). Distribution of diameter of Islets by sex was shown in Table-V.

Table-V: Distribution of diameter of Islets by sex

Sex	Diameter of Islets in micrometer (µm)		
	Range	Mean	SD
Male (n=10)	153.0-2.67	158.4	5.14
Female (n=8)	144.0-148.0	146.9	1.41
*p- value		p<0.01	

**Unpaired t test was applied to analyzed the data.*

Correlation between age and number of Islets per mm^2 was shown in Figure-3. A negative correlation (non-significant) was observed between age and number of Islets per mm^2 (r=0.173; p=0.506).

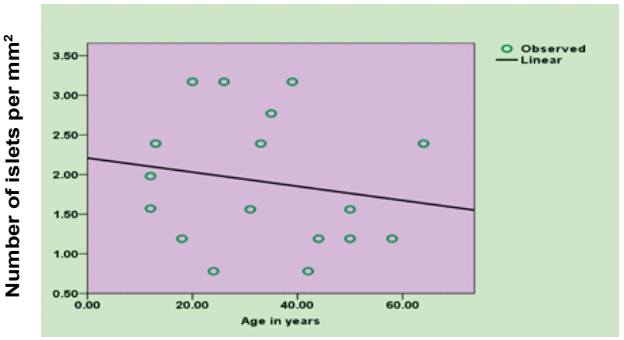

Figure-3: Scatter diagram showing correlation between age and number of Islets per mm^2 (n=18)

Correlation between age and diameter of Islets was shown in Figure-4. A positive correlation (non-significant) was observed between age and diameter of Islets (r=0.046; p=0.861).

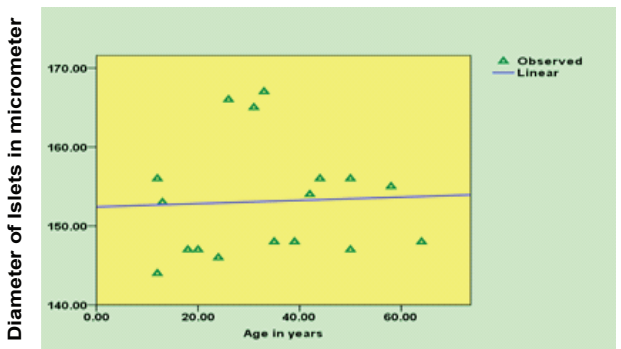

Figure-4: Scatter diagram showing correlation between age and diameter of Islets (n=18)

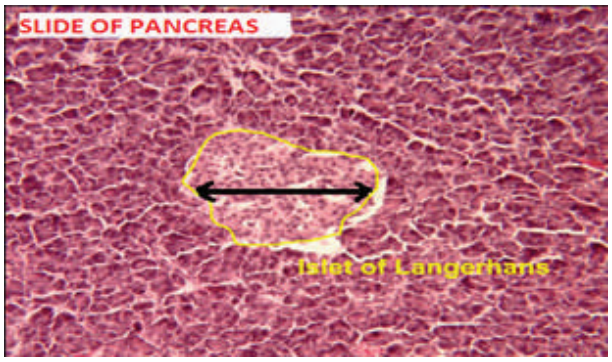

Photo-1: Photomicrograph showing diameter of Islets of Langerhans under low power objectives (X10) H&E.

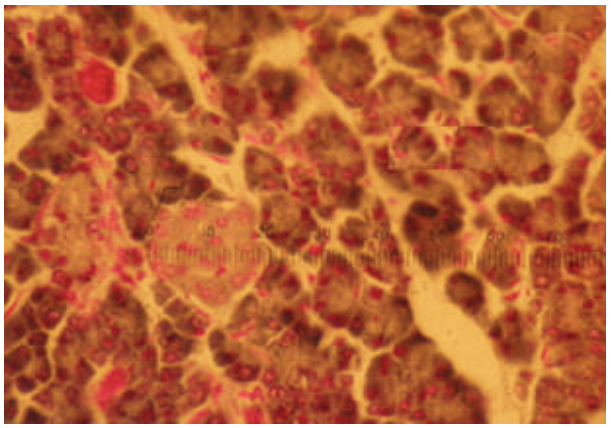

Photo-2: Photomicrograph showing measurement of islets of Langerhans with ocular micrometer.

Discussion

The pancreas is described as having a lobulated macroscopic structure, located in the retroperitoneal region approximately at the transpyloric plane. It is encased by a fine capsule and consists of lobules composed of serous secretory cells. These serous cells drain their secretions through ductules into the principal ducts. Additionally, the pancreas contains insulin-secreting Islets of Langerhans, which are interspersed among the serous alveoli.[7]

The study reports that the number of Islets of Langerhans per square millimeter of pancreatic tissue ranged from 0.78 to 3.17, with an average of 1.91 and a standard deviation of ±0.81. The authors suggest that genetic factors and dietary behavior play a role in determining the number and volume of these islet cells, referencing Basnet et al.[8] The diameter of the Islets of Langerhans ranged from 144.0 to 167.0µm, with an average of 153.44µm and a standard deviation of ±7.22. This result is noted to be similar to a previous study conducted by Firoz in 1992. The study categorizes the subjects into different age groups and examines the number and diameter of Islets within each group. It is observed that the mean number of Islets per square millimeter does not significantly differ among the age groups (5-20 years, 21-40 years and 41-64 years), with a p-value of 0.124. Similarly, there is no statistically significant difference in the diameter of Islets among the age groups (p=0.401).[9]

The study also examines gender-related differences in islet characteristics. The mean number of Islets per square millimeter in males (1.78) and females (2.08) is reported, with no statistically significant difference between the genders (p=0.449). However, a significant difference is noted in the diameter of Islets, with males having larger Islets (158.7µm) compared to females (146.9µm) (p<0.01). This finding is consistent with a previous study conducted by Firoz in 1992.[10]

The study explores the correlation between age and islet characteristics. It finds a negative correlation (though non-significant) between age and the number of Islets per square millimeter (p=0.506) and a positive correlation (also non-significant) between age and the diameter of Islets (p=0.861). The scarcity of literature on this topic makes it challenging to compare these findings with previous research.

In summary, this discussion provides valuable insights into the microscopic structure and characteristics of Islets of Langerhans in the pancreas, shedding light on how age, gender, genetics, and dietary behavior may influence these parameters. However, it is worth noting that more extensive research and comparative studies are needed to fully understand the factors affecting islet characteristics and their implications for pancreatic function and health.

Conclusion

Pancreatic diseases encompass a wide range of conditions, including diabetes, pancreatitis, and pancreatic cancer which collectively pose significant challenges to public health world-wide. This study has highlighted the notion that age-related alterations in pancreatic islet morphology may play a pivotal role in the development and progression of these diseases.

References

1. Andersen DK. Pancreas. In: Brunicardi FC, Andersen DK, Billiar TR, Dunn DLHunter JG, Pollock RE, editor. Schwartz's Principles of Surgery, 8th ed. United States of America: McGraw-Hill Companies; 2005:1221-96.

2. Anthony CP. Text Book of Anatomy and Physiology. 10th ed, St. Louis, CV Mosby Company, 1979:491.

3. Ellis H. Clinical Anatomy: Arevision and Applied Anatomy for Clinical Students. 11th ed, India, Blackwell Publishing Ltd, 2006:299-305.

4. dos Santos MF. 2007. Organs Associated with the Digestive Tract.In: Junqueira, LC editor. Basic Histology: Text and Atlas. 11th ed. New York: McGraw-Hill Companies. 2007:321-23.

5. Moore KL, Dalley II AF, Agur AMR. Clinically Oriented Anatomy. 6th ed, Philadelphia, Lippincott Williams & Wilkins, 2010:242-50.

6. Bismajian JV. Grant's Method of Anatomy. 8th ed, Baltimore, Williams and Wilkins Company, 1972:429.

7. Gartner LP, Hiatt JL. Color Text Book of Histology. 3rd ed, Philldephia, Elsevier Saunders, 2007:417-8.

8. Basnet KS, Thapa TP, Upreti RP et al. A morphometric study of human pancreas in Nepalese people. Nepal Med Coll J. 2011; 13(2):88-91.

9. Firoz A. Histological study of Islets of Langerhans of Human Postmortem Pancreas in Bangladeshi People. J Dhaka Natl Med Coll Hosp. 2010; 16(1):46-9.

10. Firoz A. An anatomical study of Human Postmortem Pancreas in Bangladeshi People [Thesis]. University of Dhaka, Bangladesh, 1992.