Original Research Article

An anatomical research study on human endocrine pancreas

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Abstract

Background: Human islet research is crucial to understanding the cellular biology of the pancreas in developing therapeutic options for diabetes patients and in attempting to prevent the development of this disease. **Objectives:** 1. To compare the macroscopic features of pancreas at different phases of life. 2. To study the microscopic appearance of pancreas and 3. Compare the Islet cell number and distribution at different parts of pancreas at different ages. **Materials and Methods:** 41 Autopsy specimens from Forensic Medicine Department of Calicut Medical College was studied Macroscopically and Microscopically after fulfilling the ethical considerations and inclusion and exclusion criteria. **Results:** Length and weight of pancreas increases with age until 40 years. Length remains constant after 40 years while weight reduces. Islets are concentrated more on the tail of the pancreas. The number of cells per islet decreased after 6th decade. No significant change in islet size was noted. **Conclusion:** More studies are recommended with large sample size to understand the Beta cell function in diabetes Prevention.
Key Word: human endocrine pancreas.

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INTRODUCTION

The pancreas lies in the upper abdomen behind the stomach. The exocrine pancreas is a part of the gastrointestinal system that makes and secretes digestive enzymes into the intestine, and also an endocrine organ that makes and secretes hormones into the blood to control energy metabolism and storage throughout the body.[1] As an endocrine gland, it functions mostly to regulate blood sugar levels, secretes insulin, glucagon, somatostatin and pancreatic polypeptide. As a part of digestive system, it secretes pancreatin which aids in digestive process.[2] The islet of langerhans collectively comprise the endocrine pancreas are too small to be seen by gross examination and vary greatly in size; ~70% are in the size range of 50-250 µm in diameter.[3] Smaller islets are dispersed throughout the acinar lobules and most larger islets lie along the main and interlobular ducts of the pancreas. Several reports provide support for the presence of a higher population density of islets in the tail of the pancreas than in the head and body although others find no difference.[4-7] Human islet research is crucial to understanding the cellular biology of the pancreas in developing therapeutic options for diabetes patients and in attempting to prevent the development of this disease.[8] Despite the fact that heterogeneity of diabetes in man has become more and more evident, its pathology is still represented by two distinct entities: juvenile-onset and maturity-onset types of the disease. There is a differential reduction in number of Beta cells in both the types.[9]

Many researches are being conducted to understand the normal anatomy of the exocrine pancreas and its histological features in different phases of life in different populations. Taking into account the above mentioned facts, the present study has been undertaken to study the various components of human pancreas and analyze during ageing, its general macroscopic as well as

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microscopic features, and contribute to the knowledge of possible alterations occurring throughout life span in this gland.

AIM AND OBJECTIVES

1. To compare the macroscopic features of pancreas at different phases of life
2. To studey the microscopic appearance of pancreas and
3. Compare the Islet cell number and distribution at different parts of pancreas at different ages

MATERIALS AND METHODS

The study was conducted on 41 pancreatic specimens obtained between 11 to 87 years from the Autopsy Room, Department of Forensic Medicine, Medical College, Calicut after prior ethical Permission. Specimens were excluded from decomposed bodies, on bodies on whom autopsy was done after eight hours and those who had history of Diabetes Mellitus Each of the pancreases was studied macroscopically as well as microscopically. For the microscopic examination tissue bits were taken and analyzed separately from 3 regions of the pancreas – Head, Body and Tail. These bits were fixed with 10% formalin saline, dehydrated with ascending grades of alcohol, cleared in xylene and embedded in paraffin. Tissue sections, 5 microns thick were taken using a rotary microtome and stained with routine Haematoxylin-eosin stain. Some of the slides from each age group were randomly selected and subjected to special stains in order to study the connective tissue distribution pattern, the zymogen granules in the acinar cells and the different cells constituting the islet.

RESULTS

Table 1: Distribution of Study population according to the age group

Age group (yrs)	No: of Specimen	Male		Female	
		No	%	No	%
11 - 20	5	4	80	1	20
21 - 30	8	6	75	2	25
31 - 40	5	4	80	1	20
41 - 50	8	4	50	4	50
51 - 60	5	3	60	2	40
61 - 70	6	4	66.6	2	33.4
70	4	3	75	1	25
TOTAL	**41**	**28**	**68.3**	**13**	**31.7**

Table 2: Distribution of length and weight of the pancreas according to the age group

Age Group (years)	LENGTH (cm)	WEIGHT (gm)
11-20	16	69
21-30	17	73
31-40	18	81
41-50	17	77
51-60	16	74
61-70	16	72
70	16	67
Overall average	**16.6**	**73.28**

Table 3: Distribution of study population according to microscopic features of Islets in Head region of pancreas

Age Group (years)	Average No. of Islets per field	Average Diameter of Islets (μ)	Average No. of cells per islet
11-20	1	32.2	48.6
21-30	1	43.75	64.5
31-40	0.5	47	65.4
41-50	0.5	46.8	70.4
51-60	0.5	28.2	59.4
61-70	0.5	27.6	56.8
Above 70	0.5	28.5	54.7
Overall average	**0.71**	**30.72**	**59.9**

Table 4: Distribution of study population according to microscopic features of Islets in Body of pancreas

Age Group (years)	Average No. of Islets per field	Average Diameter of Islets (µ)	Average No. of cells per islet
11-20	**1.25**	39.6	75.8
21-30	**1.25**	40.6	52.87
31-40	**1.4**	43.6	83.8
41-50	**1.38**	41.25	67.8
51-60	**1.5**	36	69.8
61-70	**1.5**	35	49.8
71	**1.5**	34.25	63.5
Overall average	**1.4**	**38.6**	**66.2**

Table 5: Distribution of study population according to microscopic features of Islets in Tail of pancreas

Age Group (years)	Average No. of Islets per field	Average Diameter of Islets (µ)	Average No. of cells per islet
11-20	2.3	50	150
21-30	2.5	66.25	105.5
31-40	3.7	84	156
41-50	3.37	73.1	105.1
51-60	3.1	84	140
61-70	3.3	61.67	85.8
71	3.25	58.75	93.75
Overall average	**3.07**	**68.25**	**119.45**

Table 6: Table describing the Microscopic Observations of the Pancreas

Features	11-20 yrs	21 – 30 yrs	31–40 yrs	41-50 yrs	51-60 yrs	61-70 yrs	Above 70 yrs
Connective tissue (1)	Decreased	No change	No change	No change	No change	Slight increase	Increased
Fat deposition	nil	nil	nil	nil	*	**	***
Lobulated appearance	Typical	Typical	Typical	Typical	Typical	Disorted	Distorted at some region
				ACINI			
Arrangement	Typical	Typical	Typical	Typical	Typical	Distorted	Distorted
Bipolar staining	+	+	+	+	+	+	+
Zymogen granules	+	+	+	+	+	+	+
Centroacinar cells	+	+	+	+	+	+	+
				DUCT LINING			
Smaller ducts	Squamous/ cuboidal	Squamous/ cuboidal	Squamous/cu boidal	Squamous/ cuboidal	Squamous/ cuboidal	Squamous/cuboidal	Squamous/cuboidal
b. Larger ducts	Columnar	Columnar	Columnar	Columnar	Columnar	Columnar/cuboidal	Columnar/ cuboidal / squamous
Islet cells(3)	β>α	β>α	β>α	β>α	β>α	β>α	β>α

DISCUSSION

Observations made in the study are discussed under the following headings:

1. Macroscopy of the pancreas
2. Microscopy of the pancreas which includes the acini, duct system, connective tissue and the islets of Langerhans.

Macroscopy of the Pancreas: The average weight of pancreas was around 73 gms. The weight of the pancreas also showed a positive linear relationship with age until about 40 years of age after which it shows a negative linear relationship (Table 2). Schaffer [10] in 1926 stated that the weight of the human pancreas though variable, averages 80 grams. A decrease in the weight of the pancreas was noted in the age group of more than 70 years. (Table 2) This may be probably due to the age-related atrophy of the organ.

Microscopy of the pancreas: Exocrine portion forms the main bulk of the pancreas constituting up to 80% of the volume of the gland. It is in the form of a serous, compound tubulo- alveolar gland. In the histological sections studied, they appeared as numerous acini separated by small amounts of connective tissue in between. Saisho, Y and Butler, A. E.[11] in 2007 conducted a study on the pancreatic volume in humans from birth to age hundred and found that during childhood and adolescence, the volume of total pancreas and pancreatic

parenchyma increases linearly with age. During age 20 – 60 years pancreas volume reaches a plateau and then decreases thereafter. Our study too supports this fact. Kurtz (1961) reports the presence of electron dense pigment particles within the senile acinar cells, but such a finding was not seen in our study.[12] The connective tissue surrounding the pancreas extend into the substance of the gland as numerous septae dividing the gland into lobes and lobules. The septae carries the blood vessels ducts nerves and lymphatics. In the pancreatic sections belonging to age more than 60 years, abundant deposition of adipose tissue could be seen in between the lobes and lobules and also in the connective tissue septae at the expense of the decrement in pancreatic exocrine mass(Table 6). Andrew (1944) emphasizes that large amount of "adipose tissue" change occurs in the pancreatic lobules in the old age.[13] Many other workers like Kreel *et al*[14] (1977), Mark, *et al*[15] (1980), Noronha *et al*[16] (1981) and Wharten *et al*[17] (1932) have shown that after the age of 60 years, there is moderate to severe fat deposition in the pancreas. In this age group the connective tissue component appears to be increased when comparing to the preceding age groups. The various generations of ducts that drain the secretions of the exocrine cells of pancreas are the intercalated ducts, interlobular ducts, interlobar ducts and the main pancreatic ducts. The study of the lining epithelium of these ducts showed that the intercalated ducts are lined with flattened to cuboidal cells while interlobular ducts have the classical cuboidal epithelium. The interlobar ducts varied considerably in size. Smaller ducts had cuboidal epithelium while larger ones had columnar epithelium. But the larger ducts in older pancreas changed to cuboidal type and even to squamous epithelium (Table 6). The connective tissue provided a sheath of variable thickness around the ducts. The connective tissue fibers formed a thin layer around the ducts. An increase in the connective tissue component was seen in older pancreas. Fat cell deposition was observed in older pancreas distorting the lobular architecture of the pancreas. No age related changes were noted in the small to medium sized ducts, but the epithelium of the larger ducts showed some changes with increasing age. In some of the tissue sections belonging to age group more than 60 years it could be seen that the larger ducts were lined by cuboidal to squamous epithelium (Table 6). Balo and Ballon[18] (1929) and Andrew(1944) states that, epithelium of the larger ducts may undergo squamous metaplasia with increasing age. [13] Other senile change in duct epithelium reported is the adenomatous and cystic ductal hyperplasia with ectasia and thinner ductal epithelium by Riccillo *et al* (2004).[19] But such a change was not observed in this study. The thickness of the connective tissue lamina surrounding the ducts appeared to increase as the age increased (Table 6). In few sections of the pancreas studied, cross-sections resembling that of nerves could be seen. This may be the non-myelinated nerve fibres innervating the pancreas as described by S. A. Bencosme *et al* (1958).[20] Neuro – insular complexes consisting of an intimate association of islet and sympathetic ganglion cells have been described by Simard *et al* [21] (1942) as exceptional structures in the midst of exocrine acinar tissue. None were seen in the present study.

Endocrine component: The endocrine islets of the pancreas were first described in 1869 by a young pathologist, Paul Langerhans. These are seen as small pale staining groups amidst the exocrine ocean of acinar cells. On comparing the head, body and tail region of the pancreas it could be seen that the islets are concentrated towards the tail of the pancreas in all the age groups studied. The average number of islets per low power field in the head region was 0 – 1; in the body region was 1 – 2 and in the tail region was around 3 (Table 3 to 5). In adults the islets measured on an average 68 microns. The islet size increases till around 4th decade and then starts declining in all the regions (head, body and tail) of the pancreas. (Table 3 to 5. In their work Declercq *et al*[22] (1988) and Ricillo *et al*[19] (2004) reports a decrease in the islet size in aged pancreas. By contrast Reaven andReaven[23] (1981) showed an increment of islet size with age. In their study of Declercq *et al* (1988) states that the tendency of smaller and more numerous islets in old age, could be explained as an outcome of disruption of larger islets. The number of cells per islet tends to decrease as age advances around 6th decade. (Table 3 to 5). This is in accordance with the study of Declercq *et al*[22] (1988) who too states a similar decrease in islet cell number. The decrease in cells per islet was more prominent in the tail region. The change in the the proportion of the constituting cells with age was not included in the present study. It could be seen that the beta cells outnumbered the alpha cells in all the age groups studied. Declercq *et al*[22] (1988) states that, although the number of the cells of an islet decrease with age, the proportion and localization of the different types of endocrine cells remain unchanged with ageing(Table 3 to 5). Aizawa *et al*[24] (1994) states that the beta cell number increased with age and is a compensatory mechanism to decreased insulin secretion or increased insulin resistance during old age. According to Ricillo *et al*[19] (2004), within an islet the non beta cells did not show significant variation in number. It was the beta cells that increased in number and they explained it to be induced by the ageing associated insulin resistance state.The weight of the pancreas also increased with age until 40 years after which it starts declining. The age related

atrophy of the gland accounted for the decrease in weight in older pancreas. (Table 2)

CONCLUSION

The various changes noted in this study may be correlated with the various age related physiological and pathological, endocrine and exocrine ailments related to the pancreas The use of fo*et al* islet transplantation and the stem cell therapy as a treatment modality for diabetes mellitus is still on its way. These ventures require a vast knowledge about the development and morphological changes under gone by the different components of the pancreas especially the Islets of Langerhans. Hence this work, studying the various macroscopic and microscopic age related changes of the pancreas may be considered significant in this diabetic era.

REFERENCES

1. Bockman D.E. Anatomy of the Pancreas. Chapter 1: The Pancreas: Biology, Pathobiology, and Disease, Second Edition 1993, edited by Go VLW, *et al*. Raven Press Ltd., New York, pp. 1-8.
2. Grays, 2008 pg 1183 – 1190
3. Hellman, B. Actual distribution of the number and volume of the islets of Langerhans in different size classes in non-diabetic humans of varying ages. *Nature 184(Suppl 19) 1959:* 1498-1499.
4. Hellman B. The frequency distribution of the number and volume of the islets of Langerhans in man. *Acta Soc Med Ups 1959. 64:* 432-460.
5. Rahier J, Guiot Y, Goebbels R.M, Sempoux C, Henquin J.C. Pancreatic beta-cell mass in European subjects with type 2 diabetes. *Diabetes Obes Metab. 10 (Suppl 4)2008:*32-42.
6. Wittingen J, Frey C.F. Islet concentration in the head, body, tail and uncinate process of the pancreas. *Ann Surg. 179(4)1974:* 412-414.
7. Yoon K.H, Ko S.H, Cho J.H, Lee J.M, Ahn Y.B, Song K.H, Yoo S.J, Kang M.I, Cha B.Y, Lee K.W, Son H.Y, Kang S.K, Kim H.S, Lee I.K, Bonner-Weir S. Selective beta-cell loss and alpha-cell expansion in patients with type 2 diabetes mellitus in Korea. *J Clin Endocrinol Metab*. 88(5): 2300-2308, 2003.
8. John S. Kaddis, BS, Barbara J. Olack, Janice Sowinski, MS, James Cravens, MPH, Juan L. Contreras, MD, and Joyce C. Niland, PhD. Human Pancreatic Islets and Diabetes Research. JAMA. 2009 April 15; 301(15): 1580–1587
9. Willy Gepts and Philip M Lecompte The Pancreatic Islets in Diabetes. The American Journal of Medicine, January 1991; 70(105-115).
10. Schaeffer,J. H. : The normal weight of the pancreas in the adult human being – A biometric study. Anat. Rec.1926: 32:119.
11. Saisho,Y and Butler,A. E. Pancreatic volume in humans from birth to age one hundred. Clin. Anat, 2007; 20(8):933 – 942.
12. Kurtz,S. M : Ageing changes in the salivary gland and pancreas. Cited in The Anatomy of Ageing in Man and Animals by Warren Andrew, pp 160.
13. Andrew,W., 1944. The Anatomy of Ageing in Man and Mammals by Warren Andrew,pp. 160.
14. Kreel,L., Haertel,M., Katz,D. (1977). J. Comput. Assist. Tomogr 1 : 290 – 299. Cited in Amer. Jl. of Roent. 139: 1095 – 98.
15. Mark,W. M., Filly,R. A.,Callen,P. W. (1980). Radiology 137 :475 – 479. Cited in Amer. Jl. of Roent. 139: 1095 – 1098, 1982.
16. Noronha M., Ferreira de Almeida M. J, Drelling D. A. (1981). Clinical association and histopathology of minimal pancreatic inflammation. Am. Jl. Gasteroenterology 76: 114 – 119. Cited in AJR 139: 1095 – 1098, 1982.
17. Wharton GK 1932. The blood supply of the pancreas with special reference to that of islands of Langerhans. The Anatomical Record 1932; 53:55-81.
18. Balo,J and H. C. Ballon,1929. Metaplasia of basal cells in ducts of pancreas; it's consequences. Arch. Path.,vol. 17,pp. 27-43. Cited in The Anatomy of Ageing in Man and Mammals by Warren Andrew,pp. 159.
19. Riccillo,F. L, M. I. Bracamonte,G. M. Console. Histomorphological and quantitative immunohistochemical changes in the rat pancreas during ageing. BioCell.2004; 28(2): 127 – 134.
20. Bencosme S. A and Daniel C. Pease (1958). Electron microscopy of the pancreatic islets. Endocrinology 63: 1-13.
21. SIMARD, L. C.: Les complexes sympathico-insulaires du pancréas de l'homme adulte. C. R.Soc. Biol. (Paris) 119, 27–28 (1935).
22. DeClercq L, Delaere P, Remacle C(1988). The ageing of the endocrine pancreas of the rat. Mech. Ageing Dev. 43(1) : 11 – 24. Cited in Biocell 28(2) : 127 – 134,2004.
23. Reaven E. P., Gerald M. Reaven. Structure and function changes in the endocrine pancreas of ageing rats with reference to the modulating effect of exercise and caloric restriction. Jl. Clin. Invest. 1981: 68: 75 – 84.
24. Aizawa,T., Komatsu,M.,Sato,Y. (1994). ATP-sensitive K+ channel-independent glucose action in rat pancreatic beta-cell. Pancreas 9 (4): 454 – 459.

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