A COMPARATIVE STUDY OF HUMAN PANCREAS WITH OTHER MAMMALIAN PANCREAS

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ABSTRACT

Human pancreas is the largest digestive gland in the body. It has both endocrine and exocrine functions. Pancreas secretes the hormones insulin and glucagon. Insulin keeps the body in euglycaemic state as the main function of insulin is metabolism of carbohydrate. Diabetes is a disease of altered carbohydrate metabolism. At present, pancreatic transplantation is the only definitive therapy that can establish a euglycaemic state.

AIM AND OBJECTIVE

Keeping the importance of pancreatic hormones in human, the present study was carried out where we compared the pancreatic morphology of human with that of pig and goat in terms of length, breadth and weight.

MATERIALS AND METHODS

This study was conducted in the Department of Anatomy, Assam Medical College, Dibrugarh. A total of 90 specimens were included in the study and these were obtained from human, pig and goat. The human specimen (30 in number) were collected from the Forensic Medicine Department of AMCH after fulfilling the official requirements. The specimen of pig and goat (30 each in number) were collected from the local slaughter house after obtaining ethical clearance from the concerned authority. In all specimens, the length, breadth and weight was recorded with the help of measuring tape, vernier callipers and electronic weighing machine.

INCLUSION AND EXCLUSION CRITERIA

Specimen showing signs of putrefaction, any cut or crush injury and congenital anomalies were excluded from the study.

RESULT AND OBSERVATIONS

In human, the length of the pancreas ranged from 12.11 to 15.09 cm. Maximum breadth of the human pancreas ranged from 4.03 to 5.12 cm and the weight ranged from 79.13 to 102.22 gram. In goat, the length of the pancreas ranged from 12.43 to 13.79 cm, the breadth ranged from 3.03 to 4.93 cm and the weight ranged from 48.43 to 70.03 gram. In pig, the length of the pancreas ranged from 12.46 to 15.87 cm. Maximum breadth of pig pancreas ranged from 3.76 to 4.78 cm and the weight ranged from 110.01 to 150.07 gram.

KEYWORDS

Human, Pig, Goat, Comparative, Euglycaemic State, Diabetes, Insulin.

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INTRODUCTION: The human pancreas is an elongated tongue shaped pinkish gland situated at the level of 1st lumbar vertebra. The gland is divided into four parts: head, neck, body and tail. The pancreas also possess one anatomically and embryologically distinct lobe called the uncinate process.[1]

According to history, the pancreas was first identified for western civilisation by a Greek anatomist and surgeon Herophilus in 335 to 280 B.C. Only a few hundred years later, Rufus of Ephesus, another Greek anatomist gave the pancreas its name. It was first referred to as the 'finger of the liver' in the Talmud written between 200 B.C. and 200 A.D. Galen thought that the pancreas served to support and protect the blood vessels. Vesalius considered the organ a cushion for the stomach.

Diabetes is a disease of altered carbohydrate metabolism. At present, pancreatic transplantation is the only definitive therapy that can establish a euglycaemic state abolishing the need of exogenous insulin.[2] The growing demand of pancreatic transplantation leads to the consideration of other sources of donor organs. The potential of animal tissues as a new source of organ transplantation has been advocated for more than two decades. Islet tissues from abundant and accessible animal sources are being considered for xenotransplantation. Although, the islet transplantation responds a useful therapeutic tool for individuals with type 1 diabetes mellitus, the discrepancy between the number of islet recipients and the number of donors remains a major barrier to its widespread use.[3] A recent estimate concluded that only one donor pancreas is available for 333 patients with type 1 diabetes mellitus.[4] The situation is aggravated by need for several pancreas for its recipient. Thus, justifying the search for alternative sources of insulin producing cells, currently

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pig islet xenotransplantation may represent the most appropriate solution.

The use of pig tissues offer several advantages including similar structural properties between porcine and human insulin, which differ by only one amino acid.[2] Hence, it is necessary to understand the degree of functional and structural homologies between human and porcine pancreas.

In 1966, the first human pancreatic transplantation was performed at the University of Minneapolis. Islet transplantation is emerging as a treatment option for selected patients with type 1 diabetes. The limited human islet supply from cadavers and poor islet yield quality remain substantial impediments to progress in this field. Use of porcine islets holds greater promise for large scale application of islet transplantation.[5] Pig pancreas is considered the most suitable potential source of islets for xenotransplantation into patients with type 1 diabetes mellitus.[6][7]

To protect the globe from the burden of diabetes mellitus and its complications, research works and studies need to be intensified to find out the morphological and histological similarities of pancreas among mammals, so that xenotransplantation can open a new horizon for the future generations.

Anatomy of Human Pancreas: The pancreas is salmon pink in colour with a firm lobulated surface. On the basis of anatomical relation, there is very minor functional and anatomical difference between the head, body and tail region. In adults, the pancreas measures between 12 to 15 cm in length. With age, the amount of endocrine tissue use to decline as does the amount of fatty connective tissue within the substance of the gland. This leads to a progressive thinning and atrophy of the gland. The pancreas lies within the curve of first, second and third parts of duodenum and extends slightly upwards across the posterior abdominal wall to the hilum of the spleen behind the stomach. It does not lie in one plane, but is effectively draped over the structures over the retroperitoneum and the vertebral column and so forms a distinct shallow curve of which the neck and medial body are the most anterior parts. Because of its flattened shape, the parts of the pancreas particularly the body are often referred to as having surfaces and borders.[1]

Anatomy of Goat Pancreas: In goat, the pancreas is located in the craniodorsal part of the abdomen in close association to duodenum. It can be divided into three parts: a body and left and right lobes. The lobes are loosely united by interlobular connective tissue. Connective tissue contains blood vessels, nerves and lymphatics. Generally, the portal vein runs between the left and right lobes. The pancreas is roughly V shaped in all species. There are two ducts present in the pancreas. Their presence reflects the convergent development pattern of the organ. However, in some species, one or other of the ducts may atrophy. The pancreatic duct is the biggest of the two and opens into the duodenum with the bile duct at the major duodenal papilla. The accessory duct opens on the opposite aspect of the duodenum at the minor duodenal papilla.[8]

Anatomy of Pig Pancreas: In porcine, the pancreas extends across the dorsal wall of the abdominal cavity caudal to the stomach. It is triradiate or triangular in shape. The right lobe is attached to the first curve (flexura-portalis) of duodenum and here the duct passes to the bowel. Left lobe is related to the left extremity of the stomach, the dorsal end of the spleen and the cranial pole of the left kidney. Middle portion is related to the portal vein and the root of the mesentery. The pancreatic duct passes from the right lobe directly through the duodenal wall opening about 10 to 12 cm from the pylorus. The intralobular tissue contains fat.

MATERIALS AND METHODS: The study was carried out in the Department of Anatomy, AMCH, Dibrugarh, Assam, India. A total of 90 specimens were included in the study and these were obtained from human, goat and pig. The human specimen were collected from autopsy carried out in the Department of Forensic Medicine, AMCH, after fulfilling the necessary official procedures. The animal specimens were collected from the local slaughter-house after obtaining ethical clearance from the concerned authority. All the specimen were dissected out, examined and measured for their length and breadth with the help of measuring tape and vernier callipers. The weight of the pancreas was measured by using electronic weighing machine. The data so obtained was recorded and analysed later on. Statistical analysis was done by using unpaired "t" test and ANOVA followed by BONFERRONI test. The p values thus generated were studied to indicate the existence or absence of significant differences in the parameters under consideration between human and other mammals included in the study. The difference between the data is considered to be significant when $p < 0.05$, highly significant when $p < 0.01$ and not significant when $p > 0.05$.

Criteria for Measurement:

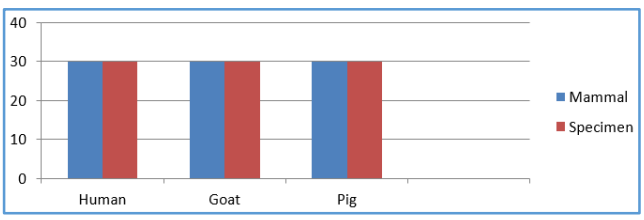
1. Length was measured between the two ends of the pancreas.
2. Maximum breadth of the pancreas was taken for all the specimens.
3. The weight of the pancreas was measured by electronic weighing machine after correcting the error of the machine.

For our convenience, we divided the mammals (specimens) into 3 groups - Group I (Human), Group II (Goat) and Group III (Pig).

RESULT AND OBSERVATIONS:

Name of the Mammals	Number of Mammals	Number of Specimens
Group I (Human)	30	30
Group II (Goat)	30	30
Group III (Pig)	30	30
Total	**90**	**90**

Table 1: Distribution of Cadavers



Graphical Representation of Distribution of Cadavers

Parameters	Minimum	Maximum	Mean±SD
Length (cm)	12.11	15.09	13.93±0.96
Breadth (cm)	4.03	5.12	4.59±0.35
Weight (gm)	79.13	102.22	86.02±7.82

Table 2: Length, Breadth and Weight of Human Pancreas

Parameters	Minimum	Maximum	Mean±SD
Length (cm)	12.43	13.79	13.02±0.35
Breadth(cm)	3.03	4.93	4.13±0.53
Weight (gm)	48.43	70.03	58.64±7.00

Table 3: Length, Breadth and Weight of Goat Pancreas

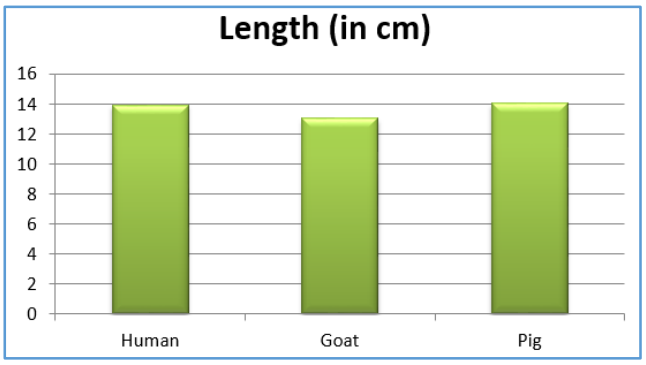
Parameter	Minimum	Maximum	Mean±SD
Length (cm)	12.46	15.87	14.03±0.94
Breadth (cm)	3.76	4.78	4.19±0.34
Weight (gm)	110.01	150.07	128.48±12.99

Table 4: Length, Breadth and Weight of Pig Pancreas

Group	Name of Mammals	Length (cm) Mean±SD	p-value
I	Human	13.93±0.96	-
II	Goat	13.02±0.35	P <.001
III	Pig	14.03±0.94	P >0.05

Table 5: Comparison of Length of Human Pancreas with that of Goat and Pig

*I vs. II: p <0.001 (significant); # I vs. III: p >0.05 (insignificant).

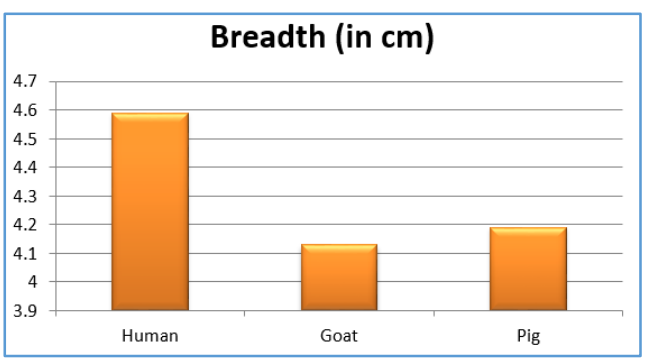


Graphical Representation of Comparison of Length of Human with that of Goat and Pig

Group	Name of Mammals	Breadth (in cm) (Mean±SD)	p-value
I	Human	4.59±0.35	-
II	Goat	4.13±0.53	P <0.001
III	Pig	4.19±0.34	P <0.001

Table 6: Comparison of Breadth of Human Pancreas with that of Goat and Pig

*I vs. II: p <0.001 (significant); # I vs. III: p <0.001 (significant).

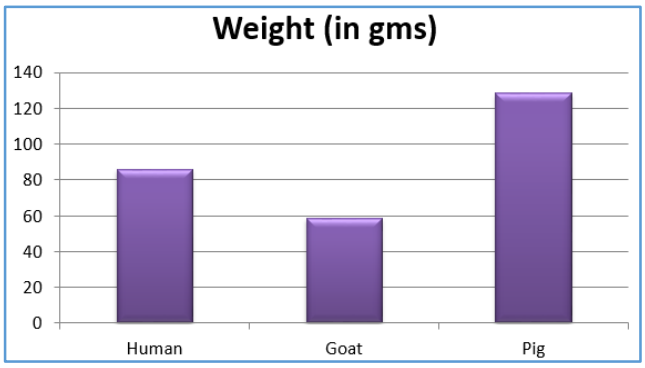


Graphical Representation of Comparison of Breadth of Human Pancreas with that of Goat and Pig

Group	Name of Mammals	Weight (in gram) (Mean±SD)	p-value
I	Human	86.02±7.82	-
II	Goat	58.64±7.00	P <0.001
III	Pig	128.48±12.99	P <0.001

Table 7: Comparison of Weight of Human Pancreas with that of Goat and Pig

*I vs. II: p <0.001 (significant); # I vs. III: p <0.001 (significant).



Graphical Representation of Comparison of Weight of Human Pancreas with that of Goat and Pig

DISCUSSION: The intention of the present study was to find out the gross morphological similarities and dissimilarities of human pancreas with that of pig and goat pancreas. We compared our findings with the findings of other authors as follows:

Length, Breadth and Weight of HUMAN Pancreas: In the present study, it was seen that the length of the pancreas in human ranged from 12.11 to 15.09 cm with a mean length of 13.02 cm. Our result were found to be similar with previous observations of Henry G 1918[9] who found it to be 12.5 to 15 cm and Manupati S et al[10] who reported it to be 12 to 15 cms. However, in a similar study, Hruban RH et al[11] stated that the length of the pancreas ranged between 14 to 20 cm, which was much higher than our findings. According to J.P. McMurich and Johannes Sobotta,[12] the length of the human pancreas ranged from 9 to 10 cm, which was lower than our range. According to Khan et al,[13] the length of the human pancreas ranged from 5.75 to 9.5 cm. His findings were also lower than our findings.

As human pancreas is a nonuniform organ, we took its widest part to be it's breadth. In our study, the breadth of the human pancreas varied from 4.03 to 5.1 cm with a mean of 4.59 cm. According to J.P. McMurich and Johannes Sobotta, the greatest breadth of human pancreas was 5 cm. Manupati S et al mentioned that the breadth of the pancreas ranged from 3 to 4 cm. Our findings were similar with that of J.P. McMurich and Manupati S et al.

In the present study, the weight of the human pancreas ranged from 79.13 to 102.22 gm with a mean of 86.02 gm. The weight of the human pancreas has been studied by various authors and it was stated to be 60 to 100 gram (Henry G 1918), about 100 gram (Hruban R.H. et al 2007) and 80 to 90 gram by A.K. Dutta.[14] Our range of weight is very similar with these authors.

Length, Breadth and Weight of GOAT Pancreas: We found the length of the goat pancreas to be ranging from 12.43 to 13.79 cm with a mean of 13.02 cm.

It was observed in the present study that the greatest breadth of goat pancreas ranged from 3.03 to 4.93 cm with a mean of 4.13 cm. On review literature search, no literature mentioning the length and breadth of goat pancreas were found in the veterinary books. We hope that the findings of the present study would prove to be an important input for any future study in this regard.

In our study, it was found that the weight of the goat pancreas ranged from 48.43 to 70.03 gram with a mean of 58.64 gm. According to Sisson and Grossman's, the weight of the goat pancreas ranged from 50 to 70 gm.

Length, Breadth and Weight of PIG Pancreas: From the morphological findings in the present study, it was observed that the length of the pig pancreas ranged from 12.46 cm to 15.87 cm with a mean of 14.03 cm and the greatest breadth of the pig pancreas ranged from 3.76 cm to 4.78 cm with a mean of 4.19 cm. As no literature mentioning the length and breadth of pig pancreas were available, our findings may prove to be an important input for any future study.

In our study, the weight of the pig pancreas ranged from 110.01 to 150.07 gram with a mean of 128.48 gm. Our findings was similar with that of R. Nickel, A. Schummer et al[15] found the weight of the pig pancreas to be ranging from 110 to 150 gram. According to Neil D.S.,[16] the weight of pig pancreas ranged from 25 to 60 gm, which is much lower than our findings.

Comparison of Length, Breadth and Weight of Human, Goat and Pig Pancreas: Among the mammals, we studied mean length of pancreas was lowest in goat and highest in pig. The mean length of human pancreas had significant difference with that of goat pancreas. But, no significant difference was noticed between mean length of human and pig pancreas.

Mean breadth of pancreas was highest in human and lowest in pig.[17] The mean breadth of human pancreas showed highly significant difference with both pig and goat pancreas. In the present study, it was observed that the mean weight of pancreas was highest in pig and lowest in goat. The mean weight of human pancreas showed highly significant difference with mean weight of both goat and pig pancreas.

From the above discussion, we can say that among the morphological parameters of human, goat and pig pancreas, the length of pig pancreas was found to be similar with human pancreas. As no literature depicting the length and breadth of pig and goat pancreas was available, we hope that our findings will be valuable in future.

CONCLUSION: From the observations made in our study, it may be inferred that morphologically pig pancreas is closer to the human pancreas. The morphological characteristics of the pancreas bear proportionality with respective body weight of the subject. The difference in size of animal pancreas with human pancreas will need to be compensated by their functional efficacy. Therefore, prior to contemplation of animal pancreas for xenotransplantation, a detailed and meticulous functional assessment of the animal pancreas for fulfilment of human physiological load is mandatory. Moreover, former studies claim that porcine

insulin is structurally closer to human insulin. We feel research works should be intensified to find out the histocompatibility of human pancreas with that of porcine pancreas, so that in future, the need of exogenous insulin can be abolished by the process of xenotransplantation.

Photograph 1: Pig Pancreas

Photograph 2: Human Pancreas

Photograph 3: Goat Pancreas

REFERENCES

1. Standring S. Gray's anatomy. The anatomical basis of clinical practice. 40th edn. Edinburgh, Scotland: Churchill Livingstone Elsevier 2008.
2. Dufrane D, Gianello P. Pig islet for xenotransplation in human: structural and physiological compatibility for human clinical application. Transplantion Reviews 2012;26(3):183-188.
3. Shapiro AM, Lakey JR, Ryan EA, et al. Islet transplantation in seven patients with type-I diabetes mellitus using glucocorticoid- free immunosuppressive regimen. N Engl J Med 2000;343(4):230-238.
4. Frank AM, Barker CF, Markmann JF. Comparison of whole organ pancreas and isolated islet transplantation for type 1 diabetes. Adv Surg 2005;39:137-163.
5. Ferrer J, Scott WE, Weegman BP, et al. Pig pancreas anatomy: implications for pancreas procurement, preservation, and islet isolation. Transplantation 2008;86(11):1503-1510.
6. Zroth CG, Korsgren O, Tibell A, et al. Transplantation of procine fetal pancreas to diabetic patients. Lancet 1994;344(8934):1402-1404.
7. Maki T, O'Neil JJ, Porter J, et al. Porcine islets for xenotransplantation. Transplantation 1996;62(1):136-138.
8. Sisson and Grossman's. The anatomy of domestic animals. Vol 1. 5th edn. WB Saunders Company 1975.
9. Henry G. Splanchnology. The pancreas. Anatomy of human body. 20th edn. Lea & Febiger 1918.
10. Manupati S, Sugavasi R, Devi IB, et al. Morphometry and histogenesis of human foetal pancreas. Int J Health Sci Res 2012;2(9):18-24.
11. Hruban RH, Pitman MB, Klimstra DS. AFIP Atlas of tumor pathology. Fourth Series, fascicle tumors of the pancreas. Washington, DC: American Registry of Pathology, Armed Forces Institute of Pathology 2007.
12. McMurich JP, Sobotta J. Atlas and text book of human anatomy. The viscera, including the heart. Vol. 2. Nabu Press 2010. ISBN-5877091662-9785877091665.
13. Khan AN. Chronic pancreatitis Imaging. Medscape Retrieved 5 January 2014.
14. Dutta AK. Essentials of human anatomy. 3rd edn. Current Distributors 1994:p. 268.
15. Nickel R, Schummer A, Sack WO, et al. The viscera of the domestic mammals. New York: Springer-Verlag 1973:199, 120-123, 136, 146, 179, 180, 197, 198.
16. Neil DS. The anatomy of the sheep- a dissection manual. 3rd edn. California: University of Queensland Press 1970:p. 371.
17. Swindle MM, Smith AC. Comparative anatomy and physiology of the pig. Scand J Lab Anim Sci 1998;25(Suppl 1):11-21.