Iraqi Journal of Veterinary Sciences

www.vetmedmosul.com

Histomorphometrical and histochemical study of the pancreas on the local dogs (*Canis lupus familiaris*)

S.L. Mostafa and Y.A. Mohammed

Department of Theriogenology, Anatomy, and Physiology, College of Veterinary Medicine, University of Duhok, Duhok, Iraq

Article information

Article history:
Received October 31, 2021
Accepted January 24, 2022
Available online March 21, 2022

Keywords:
Pancreas
Histomorphometry
Histochemistry
Local dogs

Correspondence:
Y.A. Mohammed
yahya.mohammed@uod.ac

Abstract

In the current study, ten adult healthy local dogs of both sexes were used to perform histomorphometrical study on their pancreases. The dog pancreas had an inverted V-shape consisting of left and right lobes joined by a body. The pancreas possesses both exocrine and endocrine parts. The exocrine portion was composed of numerous acini and fewer tubules as well as the duct system. The number, total diameter and cellular height of acini were significantly abundant, larger and taller in the right lobe compared those of the body and left lobe. Furthermore, the number and total diameter of large pancreatic islets were significantly abundant and larger in the left lobe despite with those of the body and right lobe. This result leads to consider the right lobe was a target region for enzymatic secretion, while the left lobe has a specific function for hormonal secretion. According to available literature, no such result and thus conclusion had been reported on dog pancreas previously. In all parts of the pancreas and with aldehyde fuchsin stain, only the large pancreatic islets contained α-, β-, δ-cells as well as non-staining cells. Only, the β-cells occurred as single cells between the pancreatic acini or even within the connective tissue septa. These single cells were more numerous in the left lobe, but they were infrequently located in the body and right lobe.

DOI: 10.33899/IJVS.2022.132567.2105,

Introduction

The pancreas has both exocrine and endocrine functions. The exocrine function is devoted to the secretion of digestive enzymes and NaCl-rich fluid into the intestine of the gastrointestinal (GI) tract (1). The endocrine portion produces hormones; primarily insulin and glucagon that regulates blood sugar levels (2). Dogs are regarded as large animal models that are physiologically, clinically and genetically more analogous to human than a mouse. Numerous common canine conditions are similar to human diseases such as diabetes, cancers, epilepsies, eye diseases and autoimmune diseases as well as rare syndromes. So, the canine models have used to develop new therapies for both human and dogs (3). On the other hand, the incidence of diabetes is increased in the last years in dogs and cats (4,5).

Due to these scientific feedbacks, dogs and their pancreases have been put at a focus of the search, so this study is planned to determine the histological structure of pancreases in local dogs by using a light microscope. Furthermore, distinguishing the histological architecture of the pancreas will be important to develop advanced strategies to treat the diseases affecting the pancreas like diabetes.

Materials and methods

Ten adult local dogs (*Canis lupus familiaris*) of both sexes were collected from Sumel town -Duhok Province, Kurdistan Region of Iraq. The weight of the animals was estimated to be between 20-30 kg. The health status of the animals was examined clinically and in the laboratory in which blood and fecal samples were collected from each

animal. The dogs were kept in cages individually at the Animal Farm-College of Veterinary Medicine, University of Duhok where they were quarantined for 14 days (6). Food and water were provided to animals during this period. Each dog fasted for 24 hours and pre-anesthetic medication including atropine sulfate (0.02 mg/kg, SC) was given to the animal. General anesthesia was induced by xylazine-HCl (1.0 mg/kg, IM) followed by ketamine (5.0 mg/kg, IM) (7). The abdomen of each dog was opened by a surgical operation at the Department of Surgery and Internal Medicine-College of Veterinary Medicine, University of Duhok. The pancreas removed from the abdominal cavity by separating it from the adjacent organs and cleaned it with normal saline. Small tissue samples 0.5 cm thickness were obtained from the different parts of the pancreas; the right lobe 5 samples, the body 2 samples and the left lobe 4 samples. The distance between the samples was about 1cm.

Some of the samples were fixed independently in 10% neutral buffered formalin for 24 hours and another in Bouin's solution for 4-18 hours. The fixed samples were dehydrated in ethanol, cleared in xylene and then embedded in paraffin wax (58-60 c^o). Serial and step serial tissue sections with 4-5 µm thick were prepared using a rotary microtome.

The tissue sections were stained by the following stain; Harris hematoxylin and eosin stain (H&E) for the demonstration of the general tissue structure (8). Masson's trichrome stain for the establishment of collagen fibers and muscle fibers (8). Gomori's reticulin method for the identification of reticular fibers (8). Weigert-Van Gieson method for demonstration of elastic fibers, collagen fibers and muscle fibers (8). Periodic acid Shiff (PAS) for identification of neutral polysaccharides (NPS) and different types of glycoproteins (9). Diastase-PAS for the establishment of glycoproteins (9). Aldehyde fuchsin for the detection of different types of pancreatic islet cells (10). All aforementioned dyes were done at Ven Hospital and Medical Complex - Duhok city using kits from Bio Gnost Company, except the last stain was performed at Duhok Research Center, College of Veterinary Medicine, University of Duhok. The tissue sections obtained from the samples were photographed by a photomicroscope (Olympus, Japan) and a camera (Leica, Germany).

The sections treated with H&E and aldehyde fuchsin stains were used for the morphometric study. Approximately 10 cross-sections of secretory units (acini and tubules) from each pancreatic part including the total diameter, luminal diameter and height of the epithelium were measured by a high-power lens (40X) as well as their number in $1mm^2$ were measured by a medium power lens (10X). Also, the number in $1mm^2$ and the total diameter of pancreatic islets were measured with the same pattern as the secretory unit number by using a medium power lens (10X). For the determination of the histomorphometric parameters, a Dino-eye piece camera provided with image software and also a computerized microscopic image analyzer attached with full HD microscopic camera (Leica Microsystems, Germany) had been used. All of the statistical analyses were performed by using SPSS program for the windows software package v.24. The numerical values were expressed as Mean ± Standard Error. For the comparisons between each sample, the statistical significance was assessed by ANOVA. The significance of differences between means considering the differences significant was established using Duncan's multiple range test at ($P \leq 0.05$).

Results

The current study revealed that the pancreas of the local dog had an inverted V shape situated on the right side of the abdominal cavity. This gland consisted of the left lobe and right lobe joined with each other by a body (Figure 1).

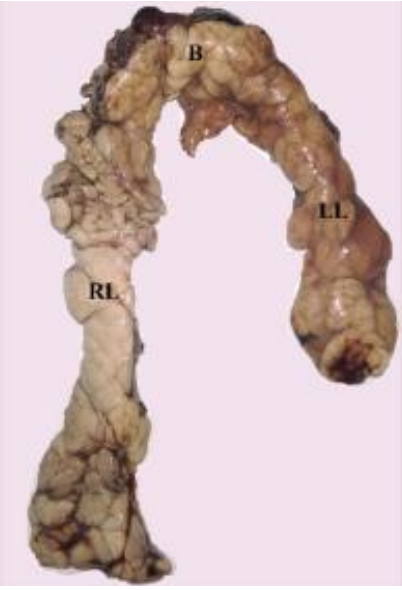

Figure 1: A photograph of the pancreas of the local dog showing: Right lobe (RL), body (B) and left lobe (LL).

Histologically, the pancreas of the local dog was surrounded by a capsule that included two elements: connective tissue and a layer of adipocytes. The connective tissue consisted of collagen and reticular fibers. The collagen fibers were restricted mainly externally and internally and the adipose layer was presented in between. In addition to that, the collagen fibers were condensed around the following components; blood vessels, lymphatics, myelinated nerve trunks and excretory ducts. The capsule was thin, but at a point of entrance or exit of the previous components, it became very thick and their elements were more abundant (Figure 2). Reticular fibers were located in the same places of collagen fibers and also formed meshwork surrounding the adipocytes.

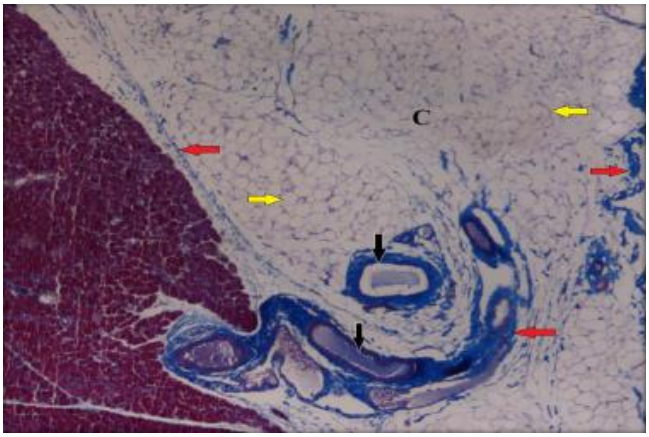

Figure 2: Microphotograph of the pancreas of the local dog (body) showing: Capsule (C), collagen fibers (red arrows), layer of adipose tissue (yellow arrows) and blood vessels (black arrows). Masson's trichrome stain: 40X.

The pancreas as a whole was separated into distinctive microscopic lobes and lobules (Figure 3). Thick septa had the same structure as that of the capsule which separated the pancreas into microscopic lobes. Thin septa consisted mainly of reticular fibers (Figure 4) as well as some collagen fibers that divided each microscopic lobe into several microscopic lobules. The collagen fibers of thin septa increased in number when surrounded by the smaller interlobular ducts and blood vessels.

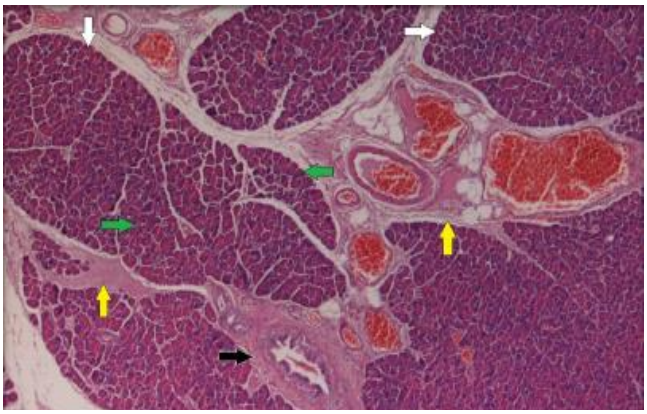

Figure 3: Microphotograph of the pancreas of the local dog (right lobe) showing: Microscopic lobes (white arrows), microscopic lobules (green arrows), thick septa (yellow arrows), large interlobular duct (black arrow). H&E stain: 40X.

Exocrine portion of the pancreas

The pancreas of the local dog was composed of exocrine and endocrine portions. This portion included pancreatic secretory units and duct system. The secretory units of the pancreas were comprised of both acini and tubules with the predominance the acini. It should be noted that a few of acini and tubules were visualized as typical cross-sections (Figure 5). Both acini and tubules were delineated partially or completely by a network of thin reticular fibers (Figure 6).

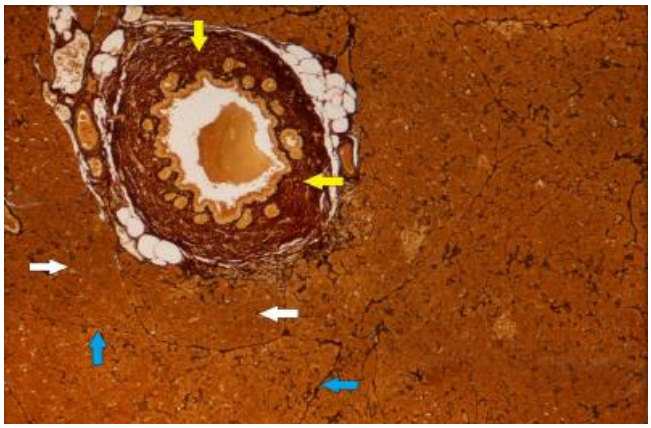

Figure 4: Microphotograph of the pancreas of the local dog (right lobe) showing: Layer of reticular fibers surrounding the proximal part of excretory duct (yellow arrows), microscopic lobules (white arrows) and thin septa (blue arrows). Gomori's reticulin stain: 100X.

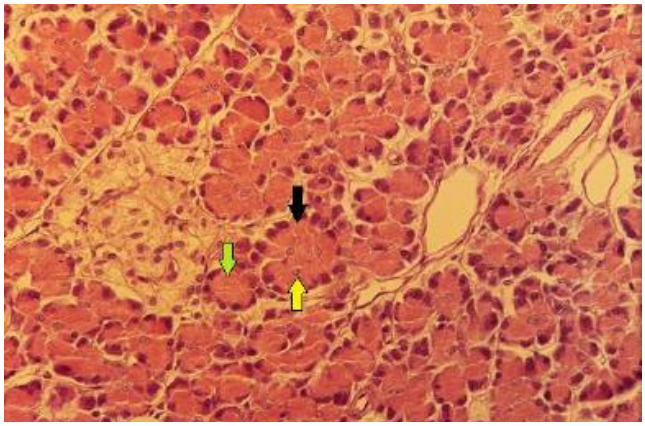

Figure 5: Microphotograph of the pancreas of the local dog (right lobe) showing: Pancreatic acinus (black arrow), pancreatic tubule (green arrow), and nucleus of centroacinar cell (yellow arrow). H&E stain: 400X.

Each acinus was lined by a single layer of pyramidal cells, whereas the tubule possessed low pyramidal cells. The nuclei of these cells were mostly spherical with condensed or light chromatin and basally located. The apical cytoplasm was acidophilic in color, while the basal part appeared basophilic. The apical and lateral surfaces of some acinar cells had a positive reaction with PAS (Figure 7) and diastase-PAS stains. The basal lamina of the capillaries related to the exocrine portion also showed PAS and diastase-PAS positive reaction.

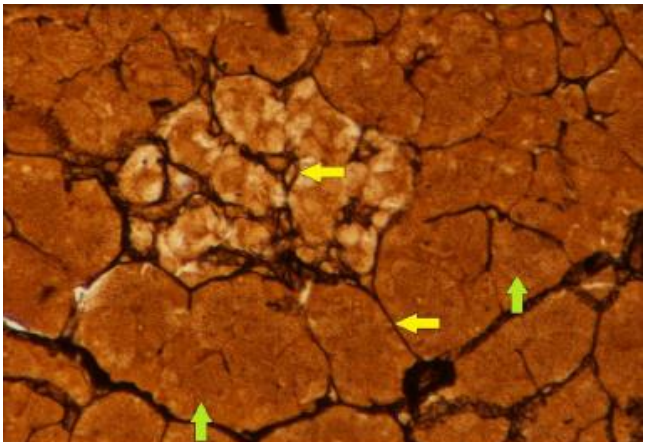

Figure 6: Microphotograph of the pancreas of the local dog (left lobe) showing: Reticular fibers (yellow arrows), pancreatic acini (green arrows). Gomori's reticulin stain: 1000X.

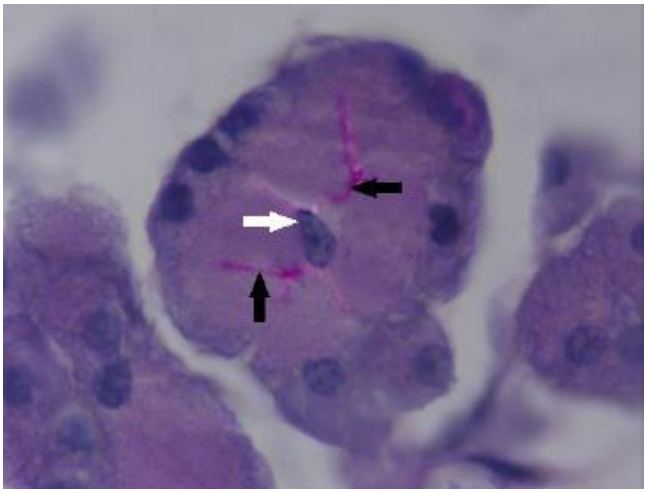

Figure 7: Microphotograph of the pancreas of the local dog (right lobe) showing: Lateral and apical surfaces of acinar cells with PAS-positive reaction (black arrows), nucleus of the centroacinar cell (gray arrow). PAS stain: 1000X.

In the right lobe, the total diameters of the acini were significantly larger (P<0.05) and the luminal diameters were significantly narrower (P<0.05) compared with those of the body and left lobe (Tables 1 and 2). Also, the cellular height of acini was significantly taller (P<0.05) in the right lobe compared with those of the body and left lobe (Table 3). Furthermore, the number of pancreatic acini in 1 mm^2 was significantly abundant (P<0.05) in the right lobe despite with that of the body and left lobe (Table 4).

All the total and luminal diameters, cellular height and number of pancreatic tubules shown non-significant differences (P>0.05) in all parts of the pancreas of the local dogs. The duct system of the pancreas included the intercalated, intralobular, interlobular, main and accessory pancreatic ducts. The intercalated duct expanded into the acinus lumen to form centroacinar cells. The light nuclei of these cells were oval or spherical with prominent nucleoli as previously been shown in figures 5 and 7. The cytoplasm of the centroacinar cells could not be demonstrated with a light microscope. The smaller intercalated and larger intralobular ducts were lined by flattened cells contained flattened dark nuclei. The epithelial cytoplasm of both preceding ducts was scant, less acidophilic and contained small PAS and diastase-PAS positive granules in some cells.

Both intercalated and intralobular ducts were surrounded externally by scant connective tissue included mainly reticular with some thin collagen fibers. The lumina of latter ducts occasionally exhibited PAS and diastase-PAS positive secretions. The small interlobular ducts were situated between the microscopic lobules and lined by cuboidal cells, whereas the largest one had low columnar epithelium and was located between the microscopic lobes. The abundant cytoplasm of these cells was more acidophilic and the lighter stained nuclei positioned centrally. A layer of connective tissue consisted chiefly of collagen with some elastic fibers (Figure 8) as well as the reticular fibers enveloped the interlobular ducts. The apical parts of some ductal cells and the lumina of these ducts contained PAS and diastase-PAS positive reactions.

Both main and accessory pancreatic ducts possessed the same histological picture. Each duct included two portions depending on their location; the proximal part was presented within the pancreas, while the distal part became free from the gland and it was directed toward the duodenum. The lining epithelia were folded and, in some places, possessed epithelial invaginations. The epithelium of these excretory ducts was composed chiefly of columnar cells with some basal cells.

Table 1: Total diameters of the acini and tubules in different parts of the pancreas of the local dog

Secretory units	Parts of pancreas [µm] (mean±SE)			*P*-Value
	Right lobe	Body	Left lobe	
Acini	36.93±2.06 ***	34.04±2.5 **	32.09±1.4 *	0.021
Tubules	23.82±0.6 *	21.68±0.5 *	19.39±2 *	0.06

- Data were expressed as the Mean ± SEM (P≤0.05) compared between three lobes.
- Different numbers of stars indicate a significant difference.

Table 2: Luminal diameters of the acini and tubules in different parts of the pancreas of the local dog

Secretory units	Parts of pancreas [µm] (mean±SE)			*P*-Value
	Right lobe	Body	Left lobe	
Acini	2.3±0.6***	4.3±0.8**	3.06±1.03*	0.034
Tubules	1.5±0.3*	1.2±0.8	1.8±0.4*	0.062

- Data were expressed as the Mean ± SEM (P≤0.05) compared between three lobes.
- Different numbers of stars indicate a significant difference.

Table 3: Cellular height of the acini and tubules in different parts of the pancreas of the local dog

Secretory units	Parts of pancreas [µm] (mean±SE)			*P*-Value
	Right lobe	Body	Left lobe	
Acini	17.15±0.4***	15.9±0.6**	14.6±1.1*	0.034
Tubules	11.28±0.3*	10.2±0.03*	9.6±0.3*	0.07

- Data were expressed as the Mean ± SEM (P≤0.05) compared between three lobes.
- Different numbers of stars indicate a significant difference.

Table 4: Number of the acini and tubules in different parts of the pancreas of the local dog

Number in $1mm^2$	Parts of pancreas [µm] (mean±SE)			*P*-Value
	Right lobe	Body	Left lobe	
Acini	140.6±4.4***	107.8±2.8**	114±5.5*	0.02
Tubules	20.06±0.99*	19.66±1.7*	19.2±1.5*	0.1

- Data were expressed as the Mean ± SEM (P≤0.05) compared between three lobes.
- Different numbers of stars indicate a significant difference.

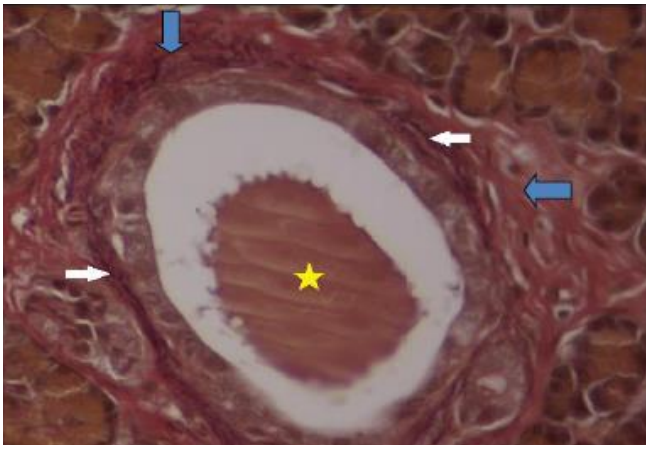

Figure 8: Microphotograph of the pancreas of the local dog (left lobe) showing: Small interlobular duct containing secretory material (yellow star), collagen fibers (blue arrows) and elastic fibers (white arrows). Weigert-Van Gieson stain: 400X.

The columnar cells had abundant cytoplasm with light oval centrally located nuclei. The basal cells had little cytoplasm with small dark nuclei and did not reach the surface of the epithelium. The description of the connective tissue layer that surrounded the proximal parts of both main and accessory pancreatic ducts was similar to that of interlobular duct, except that the layer became thicker compared with the interlobular duct. Also, the proximal part had condensed reticular fibers beneath their ductal epithelium as previously shown in (Figure 4) and their lumina were wider compared with previous ducts. The apical part of the ductal cells of both proximal (Figure 9) and distal portions of two excretory ducts had PAS and diastase-PAS positive reactions are like that of the interlobular ducts.

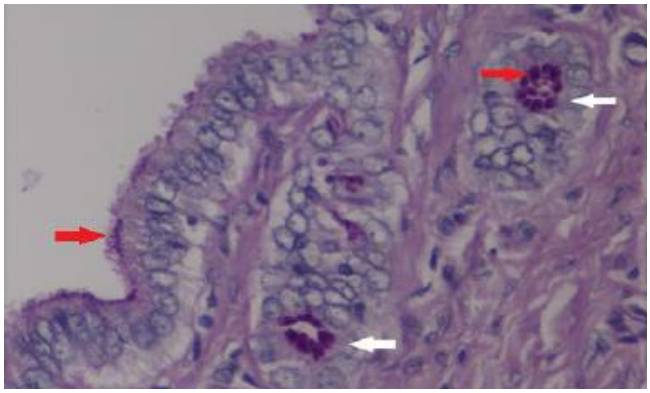

Figure 9: Microphotograph of the pancreas of the local dog (right lobe) showing: Apical parts of ductal epithelial cells of the proximal part of the excretory duct had PAS positive reaction (red arrows), deep invaginations (white arrows). PAS stain: 400X.

In the distal part of both excretory ducts, the epithelial invaginations were increased and they became deep and appeared as cross-sections. The connective tissue layer gradually decreased in thickness, especially where it reached close to the wall of the duodenum. Furthermore, the lumina of these ducts became smaller and irregular. The serial histological sections revealed that the distal portion penetrated the tunica serosa; the outer longitudinal and inner circular layers of tunica muscularis of the duodenum (Figure 10).

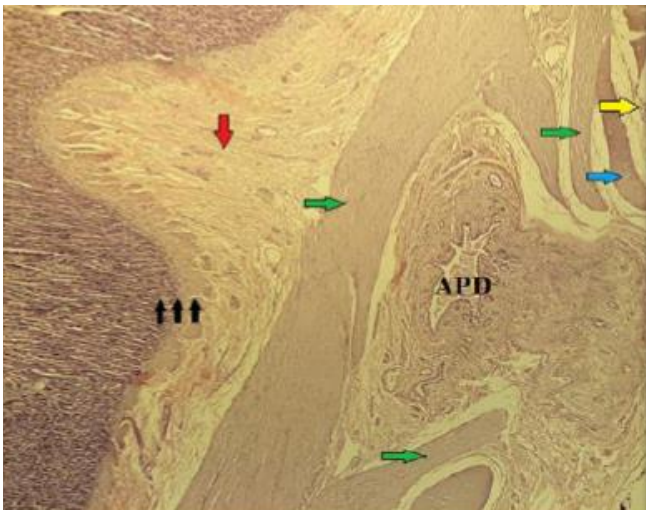

Figure 10: Microphotograph of the minor duodenal papilla showing: Distal part of the accessory pancreatic duct (APD), tunica serosa (yellow arrow), the outer layer of the tunica muscularis of the duodenum (blue arrow), the inner layer of the tunica muscularis of the duodenum (green arrows), tunica submucosa of the duodenum (red arrow), tunica mucosa (black arrows). H&E stain: 40X.

Both major and minor duodenal papillae were characterized by the presence of features associated with the distal parts of the main and accessory pancreatic ducts. Firstly, the submucosa became thicker and formed pyramidal-shaped (Figure 10). Small bundles of smooth muscle fibers originated from the inner region of the inner circular layer surrounded the distal parts of both excretory ducts in a circular manner (Figure 11). At a point of the opening of the distal parts of both main and accessory ducts, the muscularis mucosa and intestinal villi of the duodenum were absent and the lining epithelia of these ducts continued with the surface epithelium of the duodenal mucosa.

Endocrine portion of the pancreas

The present study exhibited that the pancreatic islets (Islets of Langerhans) were identified easily as aggregated cells of lighter colored randomly distributed among darkly stained pancreatic secretory units. These islets were varied to appear as irregular or oval or spherical in shape. Based on the microscopic inspection, three sizes of pancreatic islets; small, medium and large were presented in all parts of the pancreas; right lobe, body and left lobe (Figure 12).

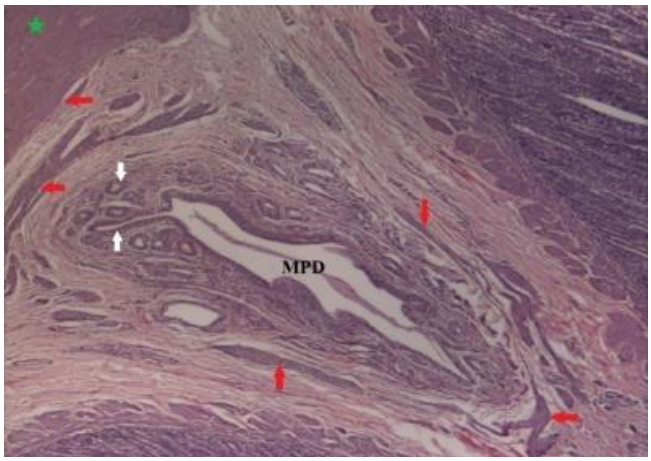

Figure 11: Microphotograph of major duodenal papilla showing: Distal part of the main pancreatic duct (MPD), the inner layer of the tunica muscularis of the duodenum (green star), deep invaginations (white arrows), and small bundles of smooth muscle fibers (red arrows). H&E stain: 100X.

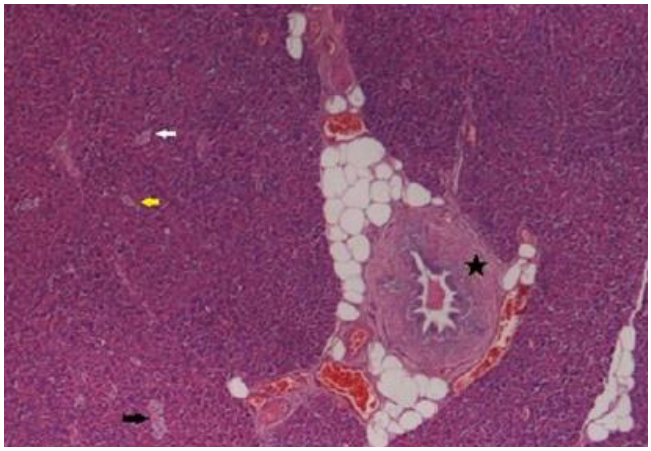

Figure 12: Microphotograph of the pancreas of the local dog (left lobe) showing: Different sizes of pancreatic islets; large (black arrow), medium (white arrow) and small (yellow arrow), large interlobular duct (black star). H&E stain: 40X.

The individual islet was incompletely enveloped by thin reticular fibers that separated the islet from the adjacent surrounding secretory units. In the interior of the islet, only the blood capillaries were surrounded by reticular fiber as previously shown (Figure 6). The cells of the islet were distributed randomly or they arranged in small clusters. The cytoplasm of these cells contained grayish granular material. The boundaries of these cells could not be demonstrated. The

spherical or oval nuclei of islet cells contained peripherally condensed heterochromatin and at the same time, this heterochromatin was distributed with euchromatin inside the nuclei. The prominent nucleoli were obvious in some of the nuclei. Occasionally, some of the islet cells had irregular or bean-shaped nuclei. Only the basal lamina of the capillaries within the islets exhibited PAS and diastase-PAS positive staining.

With an aldehyde fuchsine stain, three cell types could be recognized depending on their different granular coloration. The β-cell had violet granules; the α-cell contained yellow granules, whereas the δ-cell possessed slightly stained green granules in their cytoplasm. In addition to that, there were other cells in which they had non-staining granules (Figure 13). This stain showed that most of the pancreatic islet cells appeared as a polygonal with definitive cell boundary. Some of these cells were situated adjacent to the blood capillaries or they occurred at a distance from them.

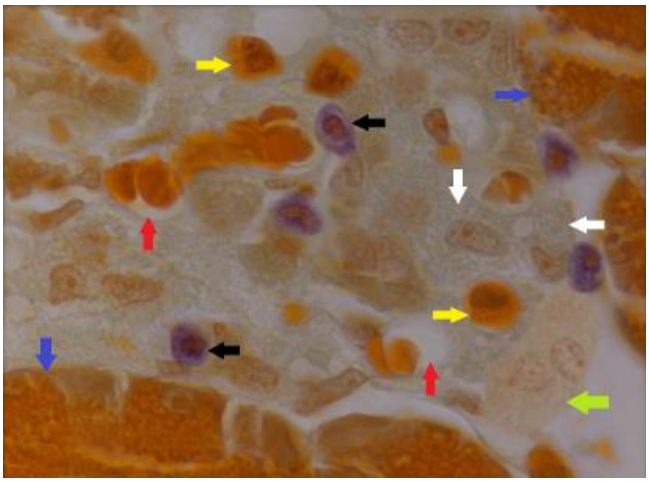

Figure 13: Microphotograph of the pancreas of the local dog (left lobe) showing: Part of the large sized pancreatic islet, α-cells (yellow arrows), β-cells (black arrows), δ-cells (white arrows), non-staining cells (green arrow), capillaries (red arrows), and pancreatic acini (blue arrows). Aldehyde fuchsin stain: 1000X.

In all parts of the pancreas, only the large pancreatic islets contained the aforementioned four types of cells. The medium and small islets had three types of cells; the δ and non-staining cells were constantly presented, while the third cells were regarded as β-cells in some islets or α-cells in other. Occasionally, the small islets comprised only two types of cells; the δ-cells were constantly occurred, whereas the second cells were β- or α- or -non-staining cells. One of the most unfamiliar things about our search was the presence of the β-cells as a single cell between the pancreatic acini or even within the connective septa (Figure 14).

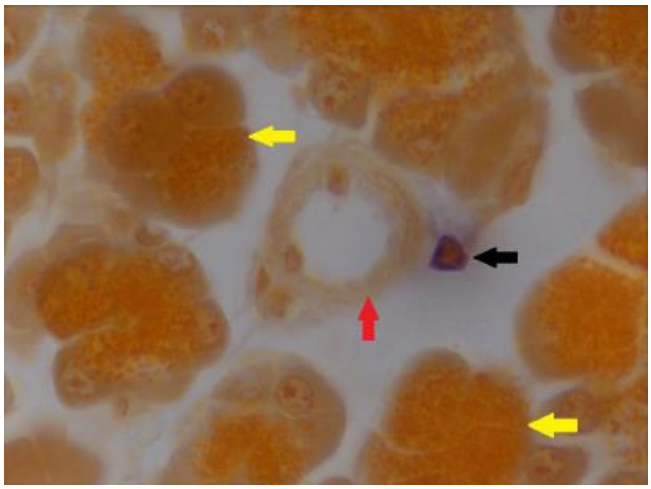

Figure 14: Microphotograph of the pancreas of the local dog (left lobe) showing: β-cell (black arrow), small blood vessel (red arrow) and pancreatic acini (yellow arrows). Aldehyde fuchsin stain: 1000X.

These cells were situated adjacent to or at a distance from capillaries or the small blood vessels. The cytological features of these cells were similar to β-cells of pancreatic islets. These single cells were more numerous in the left lobe, but they were infrequently located in the body and right lobe. Because the large islets were more prominent and included four types of cells, therefore the diameters of these islets were measured in all parts of the pancreas of the local doges. The statistical analysis of islet sizes showed that the islets were significantly larger ($P<0.05$) in the left lobe of the pancreas compared with those of the body and right lobe (Table 5). Also, the mean number of the islets in $1mm^2$ of the left lobe was significantly abundant ($P<0.05$) than that of the body and right lobe (Table 5).

Table 5: Means of size and number of the islets in $1mm^2$ in different parts of the pancreas of the local dog

	Parts of pancreas [µm] (mean±SE)			*P*-Value
	Right lobe	Body	Left lobe	
Size of islets	76.95±6.1*	91.3±5.2*	102.9±8.3***	0.1
Number of islets in $1mm^2$	3.6±0.5*	5±0.92*	5.6±0.35***	0.03

- Data were expressed as the Mean ± SEM ($P\leq0.05$) compared between three lobes.
- Different numbers of stars indicate a significant difference.

Discussion

The exocrine portion of the pancreas of the local dog was composed of predominance acini and fewer tubules as well as the duct system. The total diameters of the pancreatic acini were significantly larger and their cellular height was significantly taller compared with those of the body and left lobe. Furthermore, the number of acini was significantly abundant in the right lobe despite the body and left lobe. In addition to that, there was a topographical relationship of the excretory ducts to the right lobe. All these features of the right lobe might be regarded it as a target region for exocrine secretion, although the whole pancreas had both exocrine and endocrine functions (11).

In agreement with Tsuchitani *et al*. (12) in the dog and Egerbacher and Böck (13) in cats, rats, mice and guinea pigs, the duct system of pancreas of the local dog included the centroacinar, intercalated, intralobular, interlobular, main and accessory pancreatic ducts. The duct system of the pancreas was not considered as passages for the drainage of the secretion of the secretory units only, but it was involved in the digestive process. In this respect, Lee *et al.* (14) and Pallagi *et al*. (15) recorded that the acinar cells secreted an isotonic, $NaCl^-$ and H^+ rich fluid that contained various digestive enzymes. The secreted Cl^- was then exchanged to $HCO3^-$ by ductal cells to produce an alkaline fluid containing $NaHCO^{3-}$, which was essential for normal digestion.

The results of this research exhibited that the apical and lateral surfaces of some acinar and tubular cells had a positive reaction (magenta coloration) with PAS and diastase-PAS stains. These data revealed that these surfaces contained glycoprotein granules. In the current study and similar to the finding of the acini and tubules, glycoprotein granules were also distributed within the cytoplasm of some ductal cells of the intercalated and intralobular ducts or they were restricted to the apical part of the columnar ductal cells of the interlobular and excretory ducts. Egerbacher and Böck (13) documented that the principal cells of both interlobular and main pancreatic ducts had glycoprotein granules.

The goblet cells were presented in the epithelium of the accessory pancreatic duct of the rabbit (16) and in the epithelia of the interlobular and main excretory ducts of several species (13). Unlike the current study, there was no existence of the goblet cells within the epithelia along the course of the duct system; therefore, the presence of glycoprotein in acinar and tubular cells as well as the ductal cells might be compensating for the absence of goblet cells.

Most scholars when studying the pancreas, they pay little attention to the distal part of excretory ducts. The present research described this histologically in detail, since the distal part of both main and accessory ducts penetrated the wall of the duodenum to reach the submucosa where it was surrounded by small bundles of smooth muscle fibers originated from the inner circular layer of the duodenum. These fibers were arranged in a circular manner and might act as a sphincter.

In the present research, the aldehyde fuchsin stain was used to identify α-, β-, and δ-cells that possessed yellow, violet and green granules in their cytoplasm respectively. In addition to that, there were other cells that had non-staining granules. Ahmed (17) in albino rats recognized identical cells to the present study when they used the same dye. The non-staining cells in the current study might be regarded as γ-cells, ε-cells, G-cells, enterochromaffin cells, P/D1-cells or even other cells that they need immunohistochemical techniques or ultrastructure studies for demonstration.

All parts of the pancreas of the local dog contained large, medium and small pancreatic islets. Only the large pancreatic islets comprised distinct α-, β-, δ- cells as well as non-staining cells, so they were measured in all parts of the pancreases of local dogs. The result of the statistical analysis of this study revealed that the islets were significantly larger and more abundant in the left lobe compared with the body and right lobe. This result might lead to considering the left lobe as a target part for the endocrine portion. In this respect, Tsuchitani *et al.* (12) showed that the endocrine portion of the pancreas of the dog was composed of small and medium-sized islets presented in the left lobe and body of the pancreas, though the right lobe had only small islets.

The current study showed that α-, β-, δ-cells and non-staining cells scattered randomly within the different sized islets in all parts of the pancreas. In contrast to our study, in all parts of rabbit ′s pancreas, the β-cells were situated in the center and α-cells were located periphery in some islets, while other islets had centrally position of α-cells (18).

Kim *et al.* (19) and Steiner *et al.* (20) had mentioned that the cellular composition and architecture of pancreatic islets differed between and within species. The same researchers explained the variability of pancreatic endocrine cells distribution might be due to habits of feeding, physiological functions and pathological conditions like diabetes and obesity rather than the difference in species.

During the course of this finding, the β-cells were observed as a single cell between the pancreatic acini or even within the connective tissue septa. These single cells were more numerous in the left lobe, but they were infrequently located in the body and right lobe. Many authors showed the endocrine cells within the exocrine parenchyma and the ductal epithelium in different species (21-23). Depending on the immunohistochemical studies in the pancreas of cats, A-, B-, somatostatin and gastrin cells were observed as single cells or 2 or 3 cell clusters in the epithelium of ducts, interlobular connective tissues and exocrine tissues near the acini. The occurrence of these endocrine cells outside the pancreatic islet might be an indication of islet cell proliferation or neogenesis (24).

Conclusions

Depending on the statistical analysis, the features of the acini of the right lobe regarded the right lobe to be a target region for enzymatic secretion, while the features of the large islets of the left lobe considered the left lobe to be a specific portion for hormonal secretion. This result would be recommended for partial pancreatectomy to the right or left lobes for experimental studies in local dogs. The α-, β-, δ-cells were only recognized in the dog pancreas by using aldehyde fuchsin stain, whereas the non-staining cells required immunohistochemical and ultrastructural studies for their demonstration. The presence of isolated β-cells in all parts of the dog pancreas, especially in the left lobe might regard this animal as a suitable model for β-cell isolation.

Acknowledgment

The researchers extend their thanks and appreciation to the Ven Hospital and medical Complex- Duhok city for their support by providing adequate stains to complete this work.

Conflict of interest

The authors declare that there were no any of conflicts of interest with regards to the manuscript.

References

1. Criddle DN, Tepikin, AV. Bioenergetics of the exocrine pancreas: Physiology to pathophysiology. Pancreapedia: The Exocrine Pancreas Knowledge Base. 2020. DOI: 10.3998/panc.2020.17.
2. Qaid MM, Abdelrahman MM. Role of insulin and other related hormones in energy metabolism: A review. Cogent Food Agriculture.2016;1-18. DOI: 10.1080/23311932.2016.1267691
3. Hytönen MK, Lohi H. Canine models of human rare disorders. Rare diseases. 2016;4(1):1-6. DOI: 10.1080/21675511.2016.1241362
4. Behrend E, Holford A, Lathan P, Rucinsky R, Schulman R. Diabetes management guidelines for dogs and cats. J Am Anim Hosp Assoc. 2018;54:1-21. DOI: 10.5326/JAAHA-MS-6822
5. Niaz K, Maqbool F, Khan F, Hassan FI, Momtaz S, Abdollahi, M. Comparative occurrence of diabetes in canine, feline, and few wild animals and their association with pancreatic diseases and ketoacidosis with therapeutic approach. Vet World. 2018;11(4):410 -422. DOI: 10.14202/vetworld.2018.410-422
6. Bader OA, Eesa MJ. Effect of nano-magnesium oxide and harmonic scalpel on lung lobectomy healing in dogs: Clinical and cytokine study. Iraqi J Vet Sci. 2021;35(4):649-656. DOI: 10.33899/ijvs.2021.127611.1514
7. Hazra S, De D, Roy B, Bose A, Nandi S, Konar A. Use of ketamine, xylazine, and diazepam anesthesia with retrobulbar block for phacoemulsification in dogs. Vet Ophthalmol. 2008;11(4):255-259. DOI: 10.1111/j.1463-5224.2008.00639.x
8. Bancroft JD, Gamble M. Theory and practice of histological techniques. 6th ed. New York: Churchill Livingstone; 2008. 177-179 p.
9. Humason L. Animal tissue techniques. 3rd ed. San Francisco: WH Freeman and Company; 1972. 317-329 p.
10. Culling CFA, Alison RT, Barr WT. Cellular pathology technique. 4th ed. London: Butterworth Co Ltd; 1985. 478- 479 p.
11. Pandol SJ. Normal pancreatic function. Pancreapedia: Exocrine pancreas knowledge base. 2015. DOI: 10.3998/panc.2015.17
12. Tsuchitani M, Sato J, Kokoshima H. A comparison of the anatomical structure of the pancreas in experimental animals. J Toxicol Pathol. 2016;29:147-154. DOI: 10.1293/tox.2016-0016
13. Egerbacher M and Böck P. Morphology of the pancreatic duct system in mammals. Micro Res Tech. 1997;37:407-417. DOI: 10.1002/1097-0029
14. Lee MG, Ohana E, Park HW, Yang D, Muallem S. Molecular mechanism of pancreatic and salivary gland fluid and HCO_3- secretion. Physiol Rev. 2012;92(1):39-74. DOI: 10.1152/physrev.00011.2011
15. Pallagi P, Hegyi P, Rakonczay ZJr. The physiology and pathophysiology of pancreatic ductal secretion: The background for clinicians. Pancreas. 2015;44(8):1211-1233. DOI: 10.1097/MPA.0000000000000421
16. Al-Saffar FJ, Al-Hasnawy AHA. Histomorphological developmental study of advanced postnatal of the pancreas of local rabbit. J Biol Sci. 2014;14(6):387-402. DOI: 10.3923/jbs.2014.387.402
17. Ahmed R. Gross, histological and histochemical studies on the pancreas of albino (*Rattus norvegicus*) [master's thesis]. Tirupati: University of Sri Venkateswara Veterinary; 2013.
18. Mohammed YA. Histological and ultrastructural studies of the pancreas of native rabbits (*Oryctolagus cuniculus*). Iraqi J Vet Sci. 2019;33(2):371-378. DOI: 10.33899/ijvs.2019.163082
19. Kim A, Miller K, Jo J, Kilimnik G, Wojcik P, Hara M. Islet architecture:a comparative study. Islets. 2009;1:129-136. DOI: 10.4161/isl.1.2.9480
20. Steiner DJ, Kim A, Miller K, Hara M. Pancreatic islet plasticity: Interspecies comparison of islet architecture and composition. Islets. 2010;2(3):135-145. DOI: 10.4161/isl.2.3.11815
21. Wieczorek G, Pospischil A, Perentes E. A comparative immunohistochemical study of pancreatic islets in laboratory animals (rats, dogs, minipigs, nonhuman primates). Exp Toxicol Pathol. 1998;50 (3):151-172. DOI: 10.1016/S0940-2993(98)80078-X
22. Simsek N, Kaya M, Kara A, Can I, Karadeniz A, Kalkan Y. Effects of melatonin on islet neogenesis and beta cell apoptosis in streptozotocin-induced diabetic rats: An immunohistochemical study. Domest Anim Endocrinol. 2012;43(1):47-57. DOI: 10.1016/j.domaniend.2012.02.002
23. Al-Haaik AG. A gross anatomical and histological study of pancreas in adult Kestrel (*Falco tinnunculus*). Iraqi J of Vet Sci. 2019;33(2):175-180. DOI: 10.33899/ijvs.2019.162960
24. Karaca T, Kara A, Şimsek N, Uslu S, Tekiner D, Yörük M. Immunohistochemical distribution of glucagon, insulin, somatostatin, gastrin and serotonin-containing cells in the pancreas of the Van cat. Turk J Vet Anim Sci. 2014;38(3):304-311. DOI: 10.3906/vet-1309-72

دراسة نسجية قياسية ونسجية كيميائية لبنكرياس الكلاب المحلية

سميان لقمان مصطفى و يحيى أحمد محمد

فرع الولادة والتشريح والفسلجة، كلية الطب البيطري، جامعة دهوك، دهوك، العراق

الخلاصة

تم استخدام عشرة كلاب محلية بالغة سليمة ومن كلا الجنسين لإجراء دراسة نسجية قياسية على بنكرياس هذه الحيوانات. يمتلك بنكرياس الكلب شكل الرقم ٧ المعكوس ويتألف من فصين أيسر وأيمن مرتبطين بجسم. تتألف غدة البنكرياس نســجيا من جزء خارجي الافراز وجزء صماوي

الافراز. يتكون جزء خارجي الافراز من عديد من العنيبات وقليل من النبيبات الافرازية فضلا عن الجهاز القنوي. امتازت العنبات الافرازية بأعدادها الكثيرة وأقطارا الكبيرة وكذلك ارتفاعات خلاياها البطانية وبشكل معنوي في الفص الايمن للبنكرياس مقارنة مع تلك المتواجدة في الفص الايسر وجسم الغدة. علاوة على ذلك، كانت الجزيرات البنكرياسية ذات الاحجام الكبيرة أكثر عددا وأقطارها أكبر حجما وبشكل ملحوظ في الفص الايسر مقارنة مع تلك المتواجدة في كل من جسم الغدة وفصها الايمن. أدت هذه النتيجة إلى اعتبار الفص الأيمن متخصصا للإفراز الخارجي، بينما كان للفص الأيسر وظيفة الافراز الصماوي. وفقًا للمصادر العلمية المتاحة، لم يتم تسجيل هكذا نتيجة وهكذا استنتاج على غدة البنكرياس للكلاب سابقًا. في كل أجزاء البنكرياس، أظهرت صبغة الالديهايدفوكسين احتواء جزيرات البنكرياس الكبيرة فقط على خلايا صماوية نوع ألفا وبيتا ودلتا فضلا على خلايا لا صباغية. تتواجد خلايا بيتا الانفرادية فقط بين العنبات الافرازية وضمن حويجزات الانسجة الضامة لغدة البنكرياس. كانت هذه الخلايا الانفرادية أكثر عددًا في الفص الأيسر، لكنها نادرًا ما كانت تتواجد في الفص الأيمن وجسم الغدة.