Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/3115
DOI URL: http://dx.doi.org/10.21474/IJAR01/3115
ISSN NO. 2320-5407

RESEARCH ARTICLE

Postnatal developmental Histomorphological and histochemical study of the pancreas in the domestic cat (*Felis Catus*).

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Manuscript Info

Manuscript History

Received: 02 December 2016
Final Accepted: 03 January 2017
Published: February 2017

Key words:-
Pancreas, Islet's of Langerhans, Endocrine, cat, development, Gomori's stain, Beta cells, Alpha cells, Delta cells

Abstract

Objective: The present study was conducted to investigate the histomorphological and histochemical postnatal developmental changes established in the pancreas of the domestic cats. **Methodology**: the study conducted on three different postnatal ages that were one week (suckling kittens), 4-6 weeks (weaned immature cats) and adult of one year and up cats. Macromorphometric measurements of pancreas were conducted and listed in tables. Histological sections prepared and stained by general and special stains. **Results:** Gross findings revealed that the pancreas of cat was of compact type, of two lobes connected by small central part. Critical macromorphometric changes observed at 4 weeks aged cats. The organ drains the pancreatic secretion toward the duodenum via main pancreatic duct.

Exocrine portion more developed after birth than the endocrine portion; however both were faced developmental changes. The parenchyma provided with well duct system even in kitten. Ducts were surrounded by smooth muscle fibers invested in the connective tissue. Endocrine portion showed in kittens predominant α cells. Critical changes occurred at 4 weeks of age caused an increase of the number of ß cells so that the ratio of α / ß was changed. In adult cats the percentage of ß was predominant. In all studied ages of cats, the findings revealed the presence of well developed autonomic innervations represented by the presence of large autonomic ganglion, intramural ganglia and large sized Pacinian corpuscles. **Conclusions:** It could be concluded that pancreas was not fully developed at birth and weaning period caused critical development.

Significance of the study:

The significance of the current findings can be categorized into two criteria. First of all, it was first investigation focused on the development of the pancreas postnatally of the domestic cats in veterinary field. The second criteria, as the pancreas of the cats showed morphological similarities to those of human especially the presence of Pacinian

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corpuscles, presence and distribution of α and β cells in the islets of Langerhans, such findings will be beneficial for public health and animal health and welfare.

Introduction

The pancreas is considered an organ associated with digestive tract. It is responsible to produces enzymes conveyed into the lumen of the duodenum to aid the digestion. The organ also considered endocrine organ because it produces some metabolizing hormones. It is considered mixed gland which have the capacity to produce enzymes and hormones aid in the digestion. The function of both exocrine and endocrine portions of pancreas is therefore controlled and coordinated through both neural and hormonal regulators[1].

Histologically, it is constructed from compound, tubuloacinar acini forming exocrine portion as well as endocrine part represented by the Isle's of Langerhans. The pancreatic islet produces mainly insulin, glucagon hormones which play role in glucose metabolism[2].

Cats are commonly suffered pancreatitis and tumors in both pancreas and duodenum. They were usually affected by obstruction of the pancreatic duct in the exocrine portion associated with the inflammation of bile duct and adenocarcinoma of the duodenum. The obstruction of the duodenum cause subsequently crohn's disease in the animal. The latter characterized by dehydration, loss of appetite, loss of body weight, abdominal pain, vomiting and diarrhea[3-4].

In cats, pancreatitis recorded as a common disease in this animal species in which statistically significant higher prevalence of chronic pancreatitis observed in the left lobe of pancreas in cats severed gastrointestinal disease[3].

There is paucity of work on the histomorphological study of pancreas in the domestic cat and to our knowledge there is no local study up to date investigated the postnatal developmental histomorphological changes of the pancreas in the local domestic cats. According to the above reasons the current study was conducted to study the histomorphological and Histochemistry of the pancreas of the domestic cats at three different postnatal ages, that were one week (suckling kittens), 4-6 weeks (weaned immature cats) and adult of one year and up cats.

Materials and Methods:

Cat's collection and study design:

Clinically healthy pregnant queens were collected by hunting method and caged in the animal house till their delivery to obtain at least twelve kittens from them. Six kittens of one week of age were removed from their mothers and euthanized and these considered the first group representing suckling kittens. Other six kittens were left for not less than four weeks. These cats were euthanized and considered the second group as they represent post-weaned premature group. Six adult healthy cats of one year and up were hunted and kept under supervision in cages for one week and then euthanized as they were considered the third adult group.

Preparation of specimens

Each of the selected kitten, premature or adult cats were euthanized prior to its dissection by intra-cardiac injection of over dose of sodium pentobarbital (100 mg/kg)[5]. After that, the animal was fixed to be dissected on a dissecting board. The abdominal wall opened to view the abdominal viscera, then the duodenal loop was pointed out and the organ location and relationship with other digestive organs was photographed in situ. The topography and shape of the organs was studied and documented with aid of digital camera.

Histological procedures

The pancreas glands were removed post dissection and washed by normal saline. They were cleaned from debris and fat tissues each was divided into three anatomical parts, body (very small area), right and left lobes. Halves of these parts were fixed in 10% buffered formalin for 72 hrs, each part was trimmed and cut into slices of 1 cm thickness and the other halves were fixed in Bouin's solution for subsequent histochemical staining. Subsequent to fixation, serial sections were prepared in 6 micron thickness and were stained with Hematoxylin and eosin (H&E), Masson trichrome (MTC) and Gomori's method for pancreatic Islet cells[6].

Micromorphometric measurements:

The tissue sections were analyzed using Olympus light microscope. Sections were photographed and analyzed by Dino-eye piece camera provided with Image software.

Micromorphometric data collect on the pancreatic tissue in which the following analysis were conducted such as percentage of parenchyma tissue to whole pancreatic tissue per 1 mm^2 at different post-natal ages, densities of islets per each mm^2 to whole pancreatic tissue at different post-natal ages and percentages of α, β and δ to the sum of Islet's cells at different post-natal ages. Size of islet's of Langerhans were considered small if less than 50 µm, medium if between 50 to 75 µm and large if more than 75 µm[7]. The data on macromorphometric and micromorphometric were presented in tables.

Statistical analysis:

Statistical calculations were carried out with the SPSS 15.0 for windows software package. All numerical values were expressed as the mean ± standard error (SE). For comparisons of developmental parametric changes for all ages the statistical significance was assessed by ANOVA. The significance level was set at $p < 0.05$.

Gross Findings:

Gross examination showed that pancreas of cats was formed of three parts that were right lobe, body and left lobe (Fig. 1). The organ was of compact type of pancreas with gross obvious lobulation (Fig. 2B). The body was very small nearly square-shaped part (cm in adult) situated beside the first duodenal flexure where it form a notch traversed by the portal vein (Fig. 1). In fact the entrance of this vein considered good demarcation to the body part of the pancreas. The body connected to both right and left lobes without distinct demarcation. The right lobe of pancreas extended as ribbon shaped thin compact structure downward from the body adjacently to the mesenteric border of the descending duodenum and shortly continues with the ascending duodenum. It was adherent at its distal end to prominent regional lymph node (Fig. 1). Both right lobe and duodenum were held together by the duodenal mesentery in the abdominal cavity. The left lobe of pancreas extended from the body to the left side of abdominal cavity till the spleen and left kidney. The lobe was held by the mesentery and enforced toward the stomach by the third duodenal flexure, beginning part of the jejunum and the distal colon.

The gross findings revealed the presence of one main duct in the cat. Fine dissection revealed the presence of large branch centrally located in the core of each lobe of the organ (Fig. 3). Both branches were joined at the body just beside the first duodenal flexure to form the main pancreatic duct. Shortly this duct (2-3 cm) united with the common bile duct before it open into the lumen of the duodenum through the duodenal papilla. This papilla was situated nearly 4 to 5 cm away distal to the duodeno-pyloric junction (Fig. 2A).

Macromorphometric data of the pancreas such as length, weight of lobes was listed in table 1. The measurements of kitten's pancreas revealed that both length and weight of the right lobe were higher than those of the left lobe. The relative lengths of the left and right lobes were 40.79% and 59.21%, respectively. Whereas the relative weights of the left and right lobes were 33.33% and 66.67%, respectively.

These measurements were critically changed post 4 weeks of age in the pancreas of post weaned cats in which the relative lengths of the left and right lobes were 44.32% and 55.68%, respectively. Whereas the relative weights of the left and right lobes were 40.71% and 59.29%, respectively. The data showed marked changes in the left lobe measurements compared to those of the right one.

In the adult cats, the measurements of relative length and weight were not significantly changed when compared with the 4 weeks aged cats, as they were 43.21% and 56.78% for lengths of the left and right lobes, respectively and 40.26%, 59.73% for weights of the left and right lobes, respectively.

Microscopic findings:

Capsule:

Light microscopic findings revealed that the pancreas in cat at different postnatal ages was suspended together with the duodenum by the duodenal mesentery (Fig. 4). The latter was found microscopically formed of loose connective tissue richly supplied by blood vessels. In fact, absence of true connective tissue capsule and the organ was enclosed by very thin membrane from which many septae were formed and separating the different sized lobules of the organ. The density of the connective tissue fibers was observed surrounding the blood vessels and branches of duct system such as small and large interlobular duct as well as the main duct (Fig. 5, 6 and 7).

Exocrine portion:

A. Parenchyma:

This part was found constructed by numerous small and nearly rounded functional secretory units which may be called acini. These units were collected together forming numerous lobules which were separated from each other by very thin interlobular spaces filled with sparse and fine connective tissue fibers (Fig. 5). The connective tissue fibers

were observed in those areas which enclosed the running intercalated ducts, small intra-lobular ducts, small and large interlobular ducts (Fig. 6). Each of the secretory acini was constructed of several pyramidal-shaped cells characterized by rounded basally located nuclei and acidophilic cytoplasm filled with zymogene granules. Their nuclei were possessed small darkly stained nucleoli (Fig. 8A). Myoepithelial cells were detected adjacent to the periphery of these acini which were characterized by their flattened shape and darkly stained cells (Fig. 8B). Most of the acini were showed prominent lumen and the light microscopic examination revealed in some of them a group of cells arranged around their lumina. The latter cells are called centroacinar cells (Fig. 8). In fact, these cells are considered the first part of the duct system to carry out the products of these functional secretory units. The zymogene granules which filled the apical part of the cytoplasm were stained red post staining with H&E. Post-staining with Masson's Trichrome stain the surrounding stromal connective tissue was stained blue, characteristically those regions around blood vessels and running ducts (Fig. 5, 7). All the above stains were showed post staining of the pancreatic sections the presence of different size of structures called Islet's of Langerhans (Fig. 6). Some of these islets were just few cells gathered and embedded between the acini.

In age of one week, micromorphometric measurements showed that the ratio of parenchyma tissue (exocrine tissue) to whole tissue was 54.26 %. The data revealed that the interlobular stroma and spaces were obviously largest in the pancreas of one week kittens compared to those recorded at 4 weeks of age and adult cats. The interlobular stroma and spaces were decreased by age progress. As a result the ratio of parenchyma tissue / whole tissue of the pancreas was increased significantly into78.67% and 81.37% at 4 weeks and adult cats, respectively. In another speaking, the density of acini was increased into 81.37% in adult cats, whereas, the interalobular and interlobular connective tissue stroma were diminished by age progress (Table 2).

In age of 4 weeks, critical changes were recorded in the exocrine pancreatic tissue ended with numerous acini and well developed duct system represented by intra-lobular and interlobular duct branches as well as increased the ratio of acini / whole tissue. The acini were characterized by well stained zymogene granules. In fact, according to such changes, the pancreas is not fully developed in the newly born kitten at the first week of age.

Changes in adult cats were indicated densely packed lobules of acini units associated with well developed duct system accompanied with well developed endocrine part represented by Islet's of Langerhans. The histological data of exocrine portion showed no different features between right and left lobes of pancreas.

B. Stroma:

The stroma of the pancreas was constructed by the presence of loose connective tissue which was initiated from the thin capsule and extended into the interior of parenchyma, separating it into many lobules. The connective tissue that found around ducts and blood vessels was prominently thickened and condensed. At one week aged kittens, the stroma between lobules was loose and of extensive distances between pancreatic lobules. In the next ages, 4 weeks aged weaned cats and adult cats, these spaces between lobules were decreased due to extensive increase of acini and in another aspect it showed the presence of dense irregular connective tissue (Fig. 5).

C. Duct system:

Microscopic findings revealed the presence of prominently developed duct system in the pancreas even at one week aged kittens. It initiated by the formation of centroacinar cells. The latter were group of cells existed around the lumina of the secretory acini of the exocrine portion. The convey secretions toward other small canals to which they were connected called interalobular intercalated ducts. These ducts were small and lined by somewhat flattened simple cuboidal epithelial cells surrounded by many secretory acini. The intercalated ducts were converged together with other similar ducts forming ducts with larger diameters that were observed interalobular ducts running in the thin connective tissue separating the acini (Fig. 6). They were lined by simple cuboidal epithelial cells with rounded centrally located nuclei. In turn, these small ducts were converged together to form different sized interlobular ducts lined by low columnar to typical simple columnar epithelial cells (Fig. 15).

Large interlobular ducts (Fig. 7, 9, 10) from different parts were collected together to form larger ducts and subsequently the main duct of pancreas. The larger and main ducts were characteristically showed folds extended into the interior of their lumina. In fact, these features were absolutely specific to the main duct of the cat's pancreas. The simple columnar epithelium remains lining these latter branches of the duct system. At age of one week kittens and subsequent ages, most of these ducts were filled with secretory substances in their lumina. Post applying MTC, ages of 4 weeks and adulthood, the light microscopic examination to sections stained by MTC stain, revealed well

developed connective tissue supported the interlobular ducts, larger ducts as well as the main duct. The stain significantly stained the undulating smooth muscle fibers found intermingled between collagen fibers of the surrounding connective tissue. The blood vessels were numerously existed and accompanied the duct system at all studied ages of cats (Fig. 9, 10).

D. Pacinian corpuscles:
Prominently, pancreases of kittens and subsequent ages revealed the presence of Pacinian corpuscles distributed in different sites of the organ. They were lamellar corpuscles with oval-cylindrical in shape and have different sizes, but most of them were large considerably in size. They possessed one axon and they were entirely wrapped by a layer of connective tissue forming concentric lamellae including fibroblasts and fibrous connective tissue (Fig. 11).

E. Ganglion of pancreas:
Pancreas of one week kittens and those of subsequent ages were showed the presence of large parasympathetic ganglion. It was found adherent to the left lobe of the pancreas. The ganglion cells were large in size with rounded nuclei and small nucleoli. Their cytoplasm showed prominent missal granules. The ganglion cells were surrounded with many small darkly stained glial cells. Many small intramural parasympathetic ganglia were also detected positioned between acini and some were found in the interlobular septa surrounded with numerous blood vessels (Fig. 12).

Endocrine portion:
Endocrine portion which was resided by the presence of Islet's of Langerhans in the pancreas was developed in two directions that were enlargement of each developed Islet and by the increase of their cellular constituent. The number of the existed α, β and δ was changed and their ratio inside each Islet was changed with the progress of age.

In the pancreas of kittens, few medium sized Islet's of Langerhans were identified, whereas there was large number of very small sized islets which were constructed by a collection of few cells (6-15 cells) intermingled between acini units of the pancreas parenchyma. Mean of islet number /mm^2 of whole pancreas was 0.35 (Table 3). Post staining with Gomori's trichrome stain, cells of Islets were stained faint blue and other red in color. Those of blue color were representing β cells which were larger in size with prominent nucleus and nucleoli. They were existed mostly in the periphery of the Islet's of Langerhans. Those cells of red color representing the α cells which were smaller in size and distributed mostly in the interior of Islets (Fig. 13). At this age, pancreatic Islets comprised nearly equal number of these two types of cells but the number of α cell was slightly higher than that of β cells (Table 3). Accordingly, the percentage of α to the sum of Islet's cells was 59% and the percentage of β to the sum of Islet's cells was 40%, whereas the percentage of δ to the sum of Islet's cells was 1% (Table 4).

In pancreas of 4 week aged weaned cats, microscopic examination revealed the presence of large number of both medium sized and large Islet's of Langerhans. The existence of small sized Islets was also detected. Mean of islet number /mm^2 of whole pancreas was 2.30. The percentage of α to the sum of Islet's cells was decreased to 51.78 (Table 3) but the percentage of β to the sum of Islet's cells was increased up to 47.62%, whereas the percentage of δ to the sum of Islet's cells was 0.60% (Table 4).

The number of cellular types was changed with no changes in their interior distribution as described in the previous age of cats (Fig. 13). The shapes of large Islets were mostly irregular, whereas, the medium sized and small Islets ten to be rounded or oval in shape. The large Islets tend to be positioned at the periphery of pancreatic lobules, whereas, the medium sized one were positioned in the interior of lobules. The small Islets were located between group of acini and some of them were just few cells approximately less than 10 cells.

In pancreas of adult cats, the microscopic findings revealed numerous Islet's of Langerhans with different sizes. Numerous small Islets were observed embedded between acini and few medium and large sized Islets (Fig. 14). The distribution of Islets was still as same as those observed in the previous mentioned ages. Mean of islet number /mm^2 of whole pancreas was 2.52 (Table 3). However, number of β cell was elevated causing critical change of ratio between it and the α cell. The percentages of α, β, δ to the sum of Islet's cells was 26.88%, 72.72 % and 0.40%, respectively (Table 4).

Discussion:

The pancreas of cat was found one of solid compact type compared to other animal species where it was found of diffused or mesenteric type of pancreas. In fact such compact type also recorded previously in some animal such as hamster, dogs, monkeys and humans[8]. Whereas, differently was found diffused in animals such as rabbit[7], mouse[8], Wister rats and Sprague–Dawley rats[9].

Current remarks coincided with previous findings mentioned before as the gross anatomy of the cat's pancreas was similar to those of other commonly used laboratory and animal species such as rat, mouse, guinea pig and dog by exhibiting clearly defined right, body and left lobes[10-11].

Similarly to some species such as pig and ox the right pancreatic lobe was found closely related to the wall of the descending duodenum [12], whereas, differently to the rabbit's pancreas in which the right lobe found related to the ascending duodenum[7].

The body part of the cat's pancreas was well characterized by the passage of the portal vein through it which was considered previously in some references as a good vessel marker to this part of the organ[13].

Present findings revealed the presence of main pancreatic duct and absence of the accessory pancreatic duct in the domestic cats. The duct runs towards the proximal part of the descending duodenum and opened into duodenal lumen commonly with the bile duct. These findings were parallel with those found previously in different species of rabbit[7, 10, 14]. The presence of main pancreatic duct in domestic cats was similarly recorded in the other laboratory species such as mice, rats, guinea pigs and hamster [9, 15-17]. Similarly to the cat pancreas, the main duct was recorded in sheep and goats but differently these animals have also accessory duct [18].

Macromorphometric data revealed critical changes at 4 weeks of age. In fact, this age represent critical period in the life of animal in which fed changes post weaning time was made which required parallel changes in the digestive function of these animals. Actually, previous references postulated that the weaning is a critical period for the young mammals, because the digestive processes are maturated intensively in association with change of the feeding manners [19-21].

Microscopic findings were showed the presence of myoepithelial cells surrounding the acinar units of the pancreas. They appeared adherent to the basement membrane of the acini. These cells were found in the kittens and subsequent older ages. They were not observed around the intercalated and interalobular ducts. Similarly, in other animal species such as local rabbits these cells were found also around the acini [7].

Critical morphological changes were detected in the pancreas of 4 weeks aged cats which was currently fixed as post weaning period of life of this animal species. This period was very important during which the animal started mixed feeding. Similarly, in the local rabbits, [7] recorded critical developmental changes in the exocrine and endocrine portions of the pancreas during post weaning period of the animal.

Findings related to the duct system showed characteristic histological construction. The data revealed the presence of well developed duct branches even in one week aged kittens. Noticeably, the interlobular ducts, larger ducts and main duct were showed the presence of smooth muscle fibers running in the surrounding connective tissue of these ducts. The presence of such feature appeared prominent in the pancreas of all studied ages of cats in the present study. Previous records[22] mentioned also in ox pancreas that the interlobular ducts and the main duct were surrounded by lamina propria which contains smooth muscle fibers.

The current data recorded that the duct system in cat was started by simple epithelium which was simple squamous and ended at the main excretory duct with simple epithelium i.e. simple columnar epithelium columnar. The lining epithelium of all branches of duct system revealed absence of goblet cells which was recorded in many animal species other than cats.

The presence of such muscle fibers indicated heavy exocrine production in this animal so the contraction of these muscle fibers tends to assist rapid covey produced substances to their target organ which is the proximal part of the duodenum.

The interlobular ducts, larger ducts were showed characteristic feature which was the extended folds of epithelium into the lumina of these ducts. Moreover, in the main duct, the folds were protruded into the lumen of the duct. Current study believed that such feature aid to provide extensive surface epithelium and so subsequently increase the alkaline production which may act to decline the acidity of digested food in the duodenum caused by the stomach acidity. The presence of such morphological adaptation may be due to the feed behavior of animal as a carnivorous species.

The global changes in the size and number of Islet's of Langerhans at both 4 weeks aged cats and adult cats as well as the changes in the ratio of beta and alpha cells indicated not fully developed endocrine portion of the pancreas at birth of these animal species. The data showed critical changes at 4 weeks of age which representing the period of food intake changes by the animal.

However, recorded data indicated delayed development of endocrine portion compared to the exocrine portion of the pancreas, because at one week aged kittens, observations showed more developed exocrine portion than the endocrine one. In fact, exocrine portion revealed the formation of well developed duct system associated with the acinar units, whereas, only small group of cells were embedded in between acini were recorded as a cells of endocrine portion of the pancreas in kittens.

Characteristically, all parts of duct system were lack to goblet cells in their lining epithelium in all studied ages of cat's pancreas. It was different feature from those present in other mammalian pancreas. Noticeably, the lining epithelium remains simple in nature from first initiated part till the end of main duct. It was also different from those recorded in pancreatic ducts of other species such as the rabbit in which the main duct possess simple columnar epithelium with goblet cells.
The presence of autonomic ganglia inside and outside pancreatic tissue was also documented recently in the pancreas of the rats [23]. These ganglia were detected as a group of cells between acini of the parenchymal tissue and interlobular connective tissue or as large ganglion adjacent to pancreatic lobule.

Prominently, pancreases of kittens and subsequent ages revealed the presence of Pacinian corpuscles that were distributed in different sites of the pancreas and such feature was not present in some mammalian species. They were noticeably observed in the pancreas of all studied ages of cats. Their sizes sometime appeared equal to pancreatic lobules or even larger. The presence of these structures was also documented previously in the pancreas of human [24].

Figures:

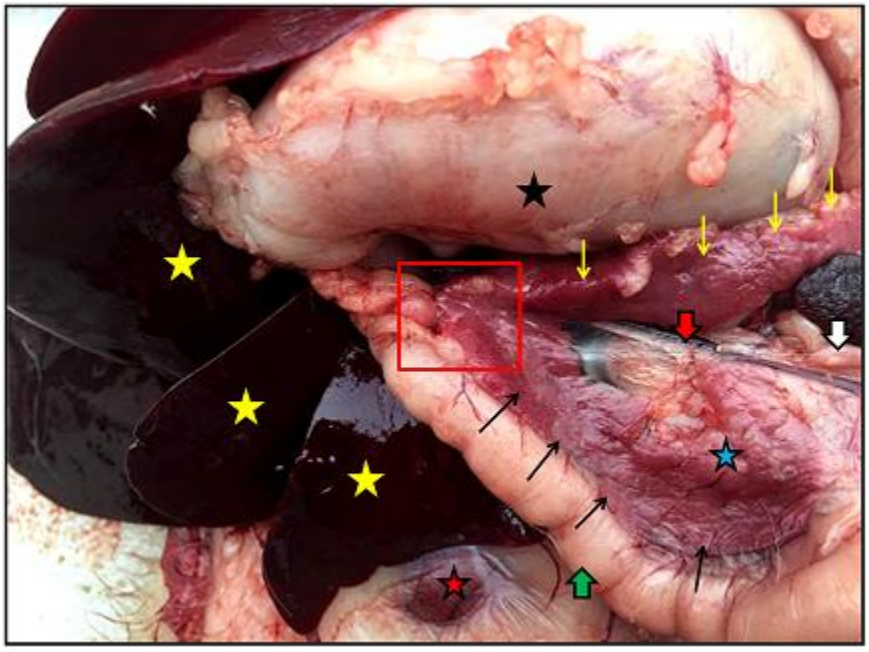

Fig. 1. Pancreas and duodenum of adult cat in situ. It showed the followings: left lobe (yellow arrows) , right lobe (black arrows), body (red rectangle) of pancreas traversed by portal vein (red arrow), descending (green arrow) and ascending duodenum (white arrow), right kidney (red star), hepatic lobes (yellow stars), stomach (black arrow).

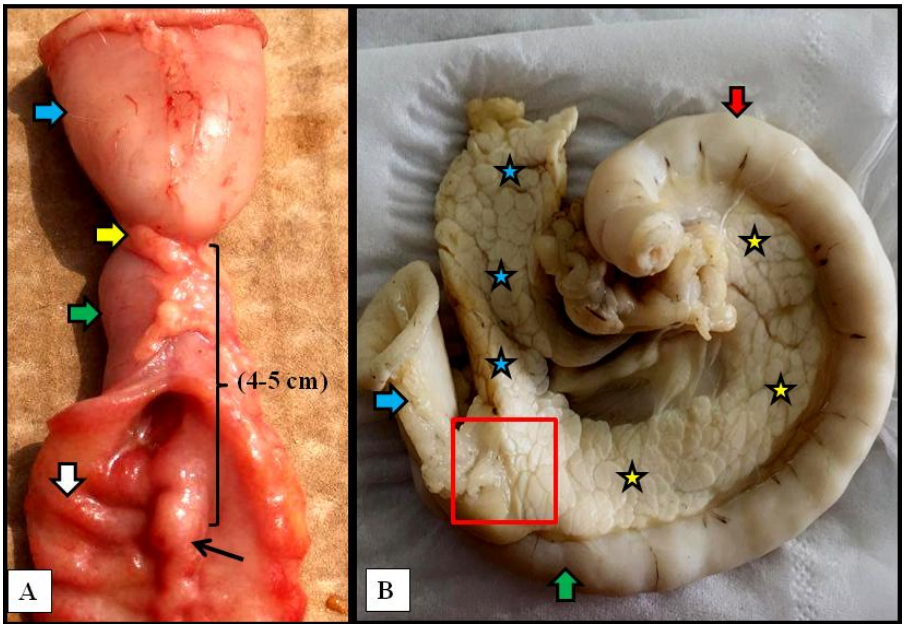

Fig. 2. A: Duodenal papilla (black arrow) inside the lumen of proximal part of the duodenum (green arrow). It showed its orifice (white arrow) around 4 to 5 cm distally to the duodeno-pyloric junction (yellow arrow), circular folds (red arrows). Blue arrow represents the pylorus. B: Dissected pancreas and duodenum of cat. It showed descending duodenum (green arrows), ascending duodenum (red arrows), left lobe (blue stars) and right lobe (yellow stars)of pancreas, pylorus (Blue arrow).

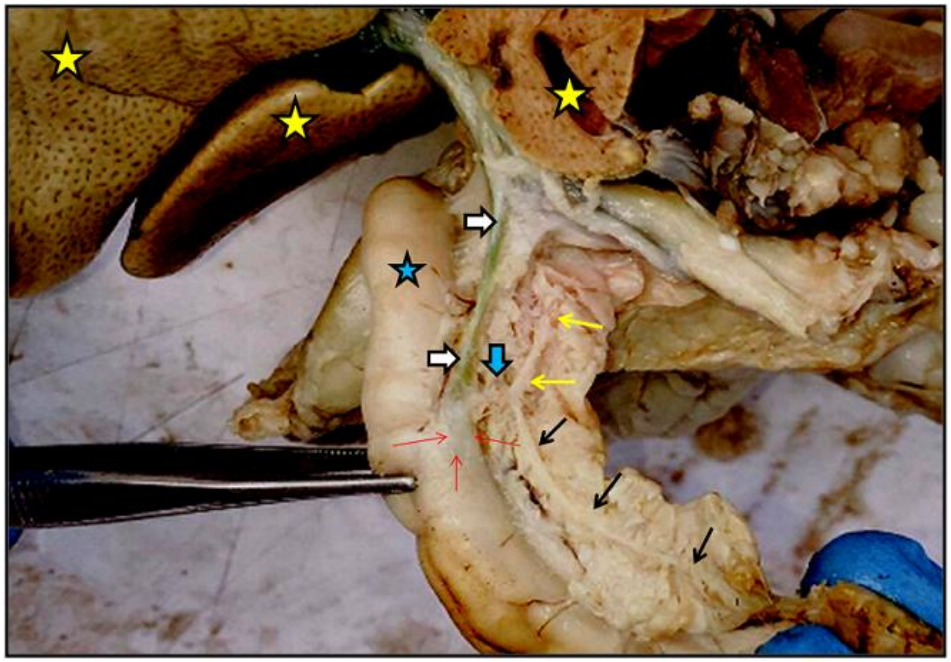

Fig. 3. Main pancreatic duct of the cat in situ. left (yellow arrows) and right (black arrows) branches of the main duct (blue arrow) ware united just parallel to the proximal part of duodenum distally to duodeno-pyloric junction (blue star), for short distance it joined the bile duct (white arrows) before its entrance into the duodenum. Yellow stars represent hepatic lobes.

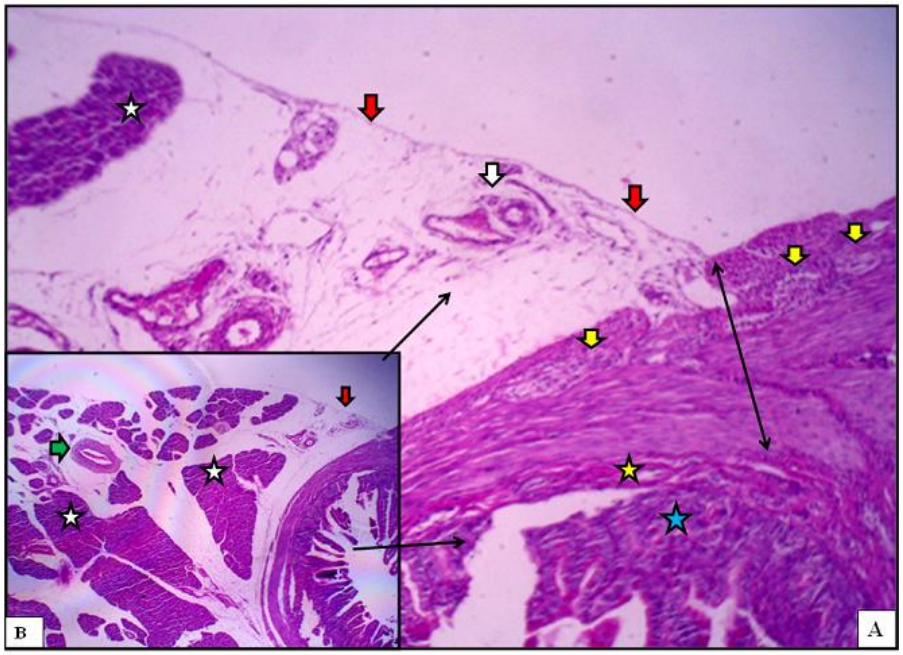

Fig. 4. Descending duodenum (A) and adjacent right lobe (B) of pancreas in one week aged kitten carried together by the mesentery (red arrow). Duodenum showed mucosa (blue star), submucosa (yellow star), Auerbach's plexuses (yellow arrows) between inner and outer layers of tunica muscularis (double head arrow). Pancreas showed lobules (white stars), interlobular duct (green arrow) and blood vessels (white arrow). H&E, X40 (A), X100 (B).

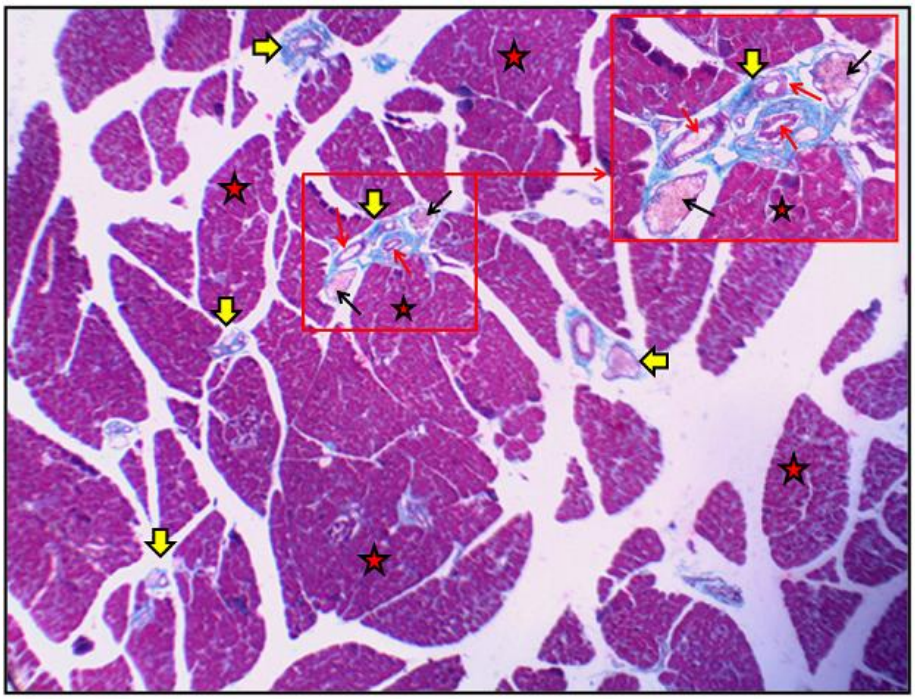

Fig. 5. Left lobe of pancreas of adult cat. It showed dense interlobular connective tissue stained blue (yellow arrows) around blood vessels (black arrows) and interlobular ducts (red arrows) as well as fine intralobular connective tissue fibers intervening between acini (red stars). Masson's Trichrome stain, X40, X100 (magnified rectangle)

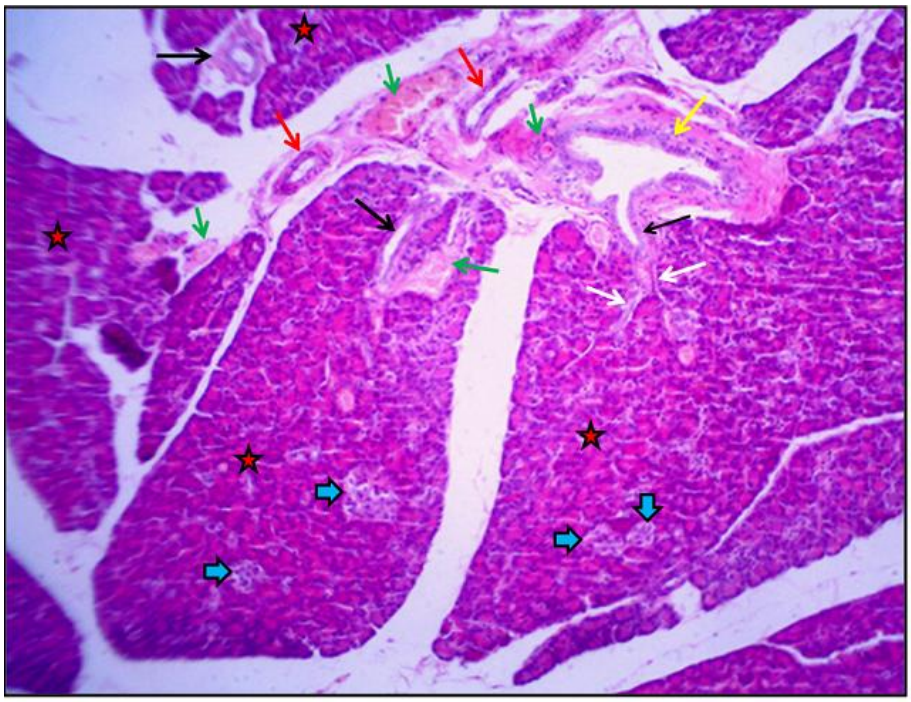

Fig. 6. Right lobe of pancreas of adult cat. It showed intercalated duct (white arrows), intralobular ducts (black arrows), small (red arrows) and large interlobular ducts (yellow arrow), blood vessels (green arrows) and Islet's of Langerhans (blue arrows) embedded in the pancreatic lobes (yellow stars). H&E, X100

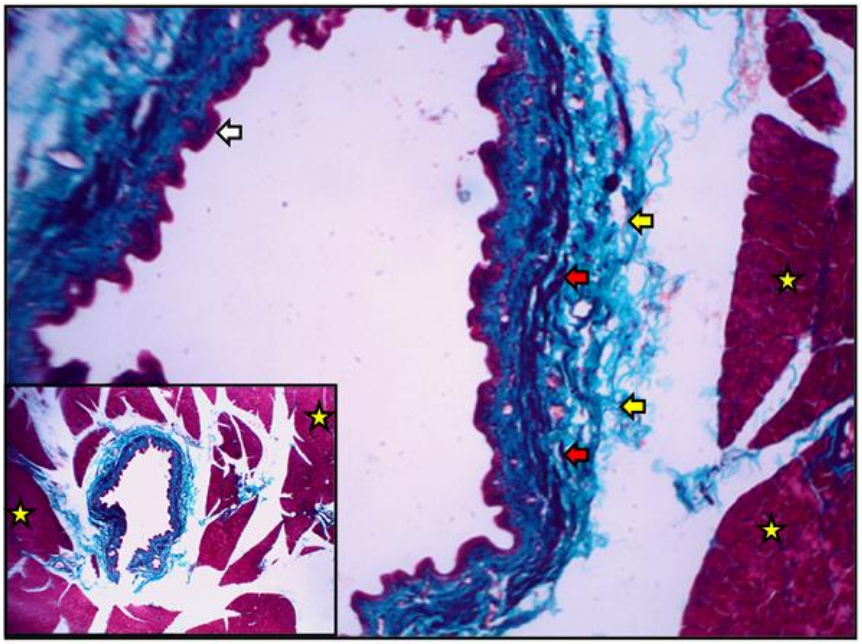

Fig. 7. Left lobe of pancreas of 4 weeks weaned cat. It showed main pancreatic duct lined by simple epithelium (white arrow), surrounded by connective tissue (yellow arrows), smooth muscle fibers (red arrows) and pancreatic lobules (yellow stars). Masson's Trichrome, X100 (small rectangle), X400

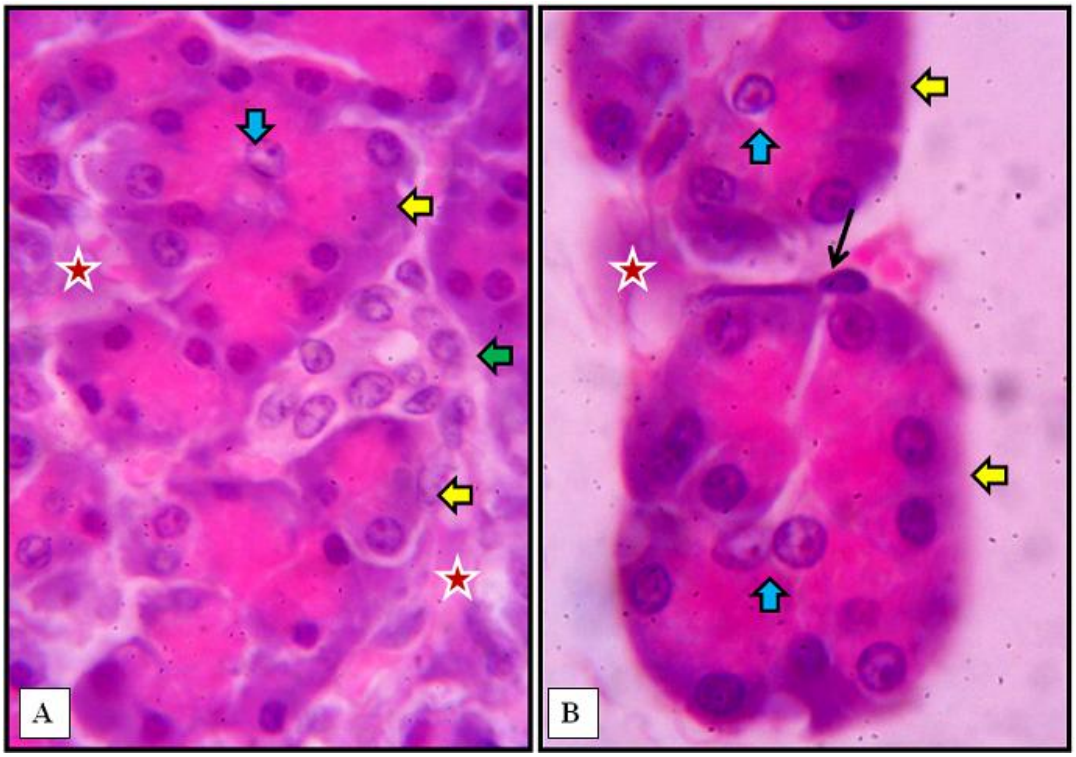

Fig. 8. A: Right lobe of pancreas of 4 weeks weaned cats. It showed acini (yellow arrows) with centroacinar cells in the lumen (blue arrow), intralobular connective tissue surrounding acini (red star) and intercalated duct (green arrow) lined with simple cuboidal epithelium. B: Pancreas of adult cat showed myoepithelial cell (black arrow) around an acinus (yellow arrows), centroacinar cells (blue). H&E, 1000

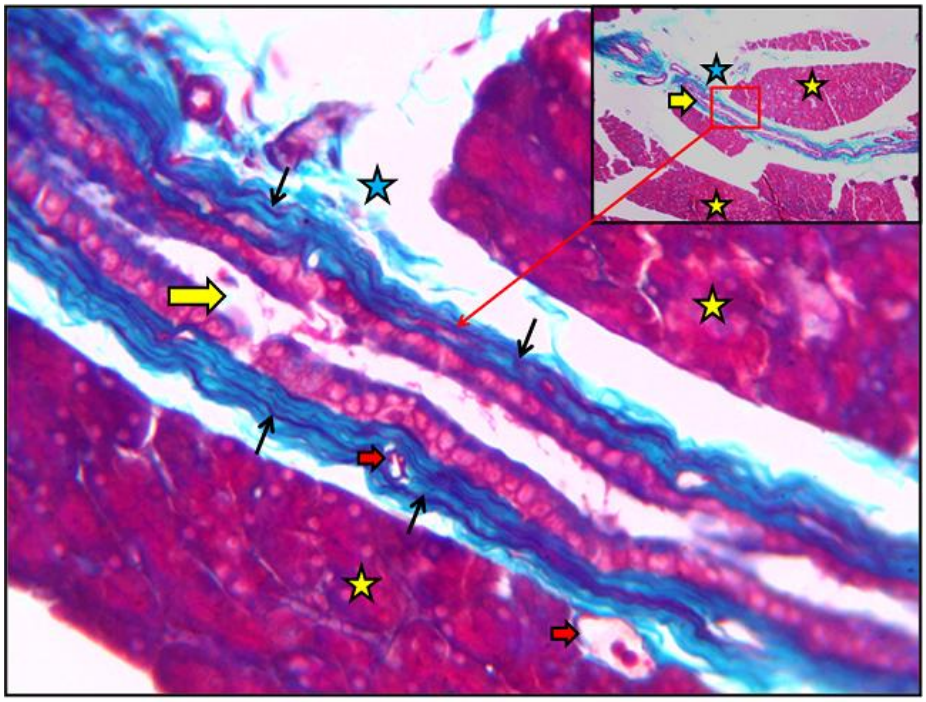

Fig. 9. Pancreas of adult cat. It showed large interlobular duct (yellow arrow) intervening between acini (yellow stars). The duct is surrounded by connective tissue (blue star) in which undulating smooth muscle fibers are found (black arrows) and blood vessels (red arrows). Masson's Trichrome, X400, X100 (small rectangle).

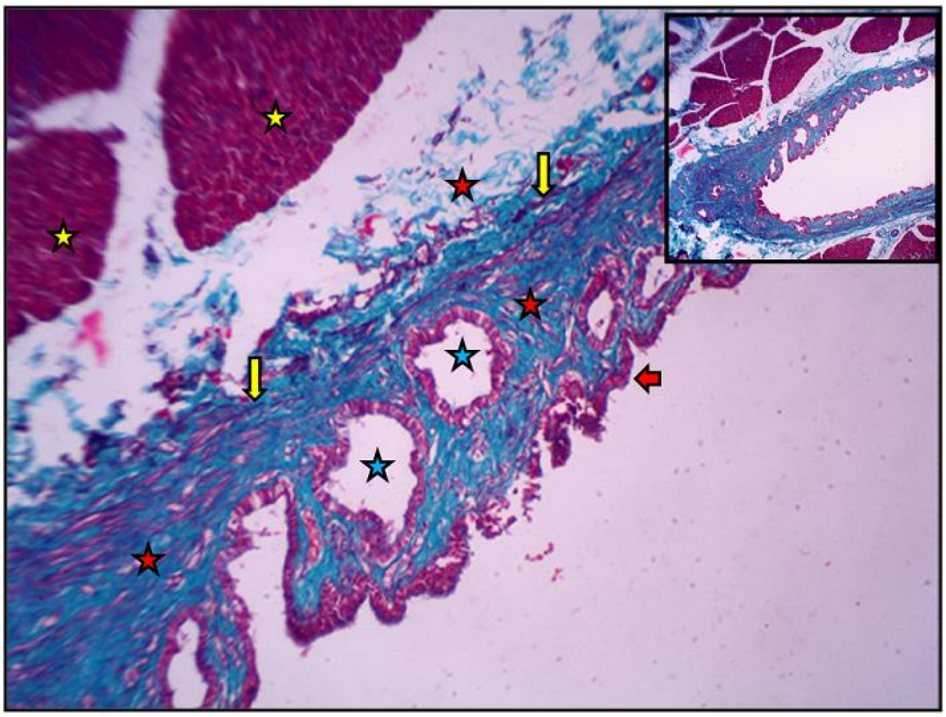

Fig. 10. Right lobe of pancreas of adult cat. It showed the right branch of the main duct into which opened many large interlobular ducts (blue stars). It is lined by simple columnar epithelium (red arrow) with the underneath connective tissue (red stars) which showed smooth muscle fibers (yellow arrows). Yellow stars represent the pancreatic acini. Masson's Trichrome, X100, X40 (small rectangle).

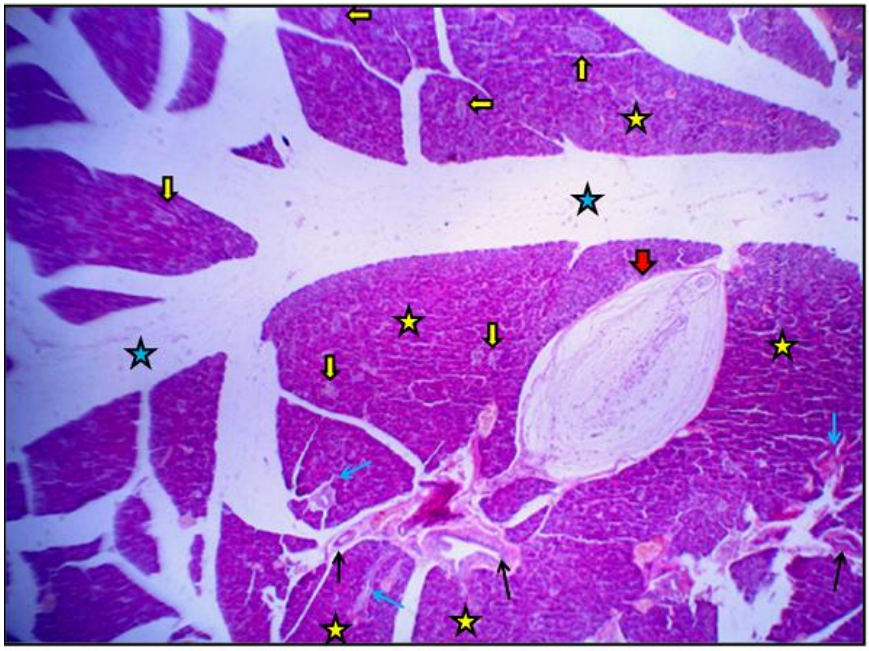

Fig. 11. Right lobe of pancreas of adult cat. It showed Pacinian corpuscle inside pancreatic lobules (red arrow). Isle's of Langerhans (yellow arrows) are present inside the lobules (yellow stars). Interlobular connective tissue (blue stars) and many intralobular (blue arrow) and interlobular (Black arrows) ducts are present. H&E, X40

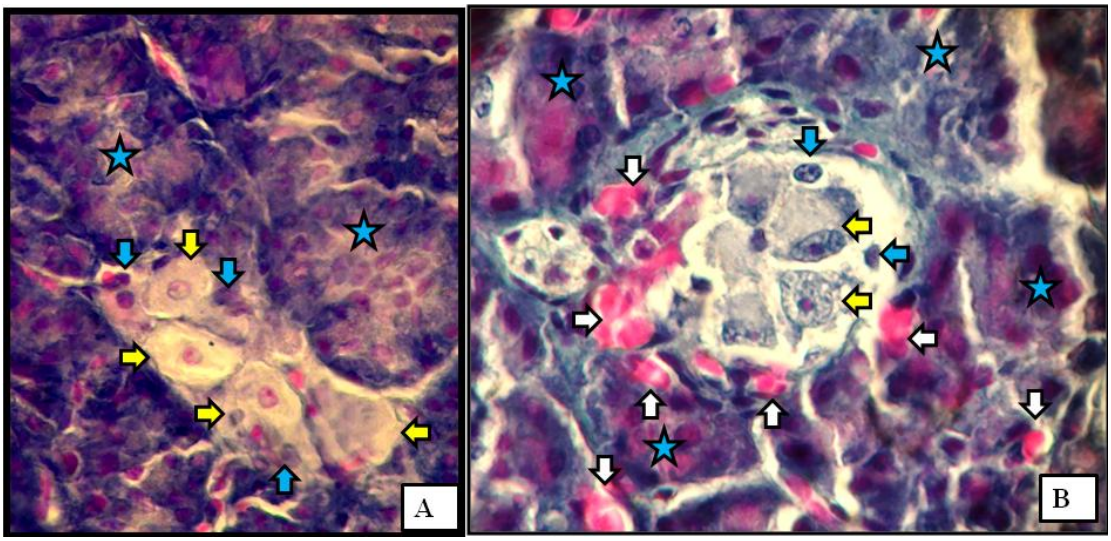

Fig. 12. Intramural ganglia in pancreas of one week (A) and 4 weeks (B) cats. It showed ganglion cells with large nuclei and nucleoli (yellow arrows) surrounded by small neuralgia cells (blue arrows). Many blood capillaries present (white arrows) and acini (blue stars). Gomori's Aldehyde trichrome, X400

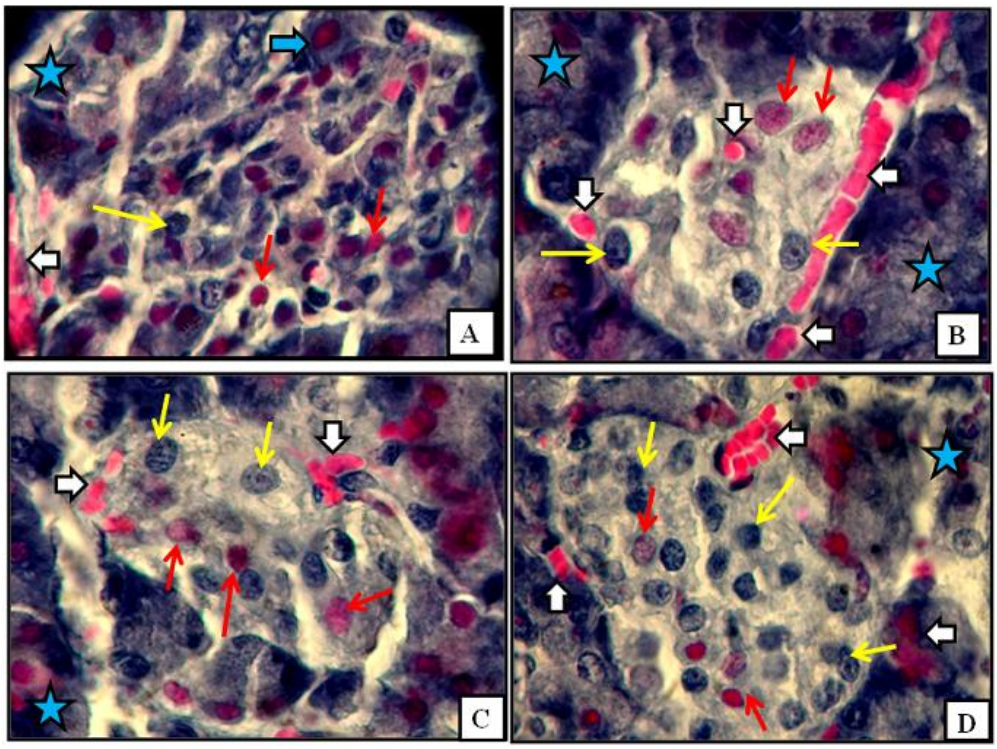

Fig. 13. Islet's of Langerhans of one week aged kitten (A), 4 weeks aged weaned cat (B), medium sized islet of adult cat (C), large sized islet of adult cat (D). It showed α (red arrows), ß (yellow arrows) and δ (blue arrow). Many blood vessels present inside and outside the islet (white arrows), and acini (blue stars). Gomori's Aldehyde trichrome, X1000

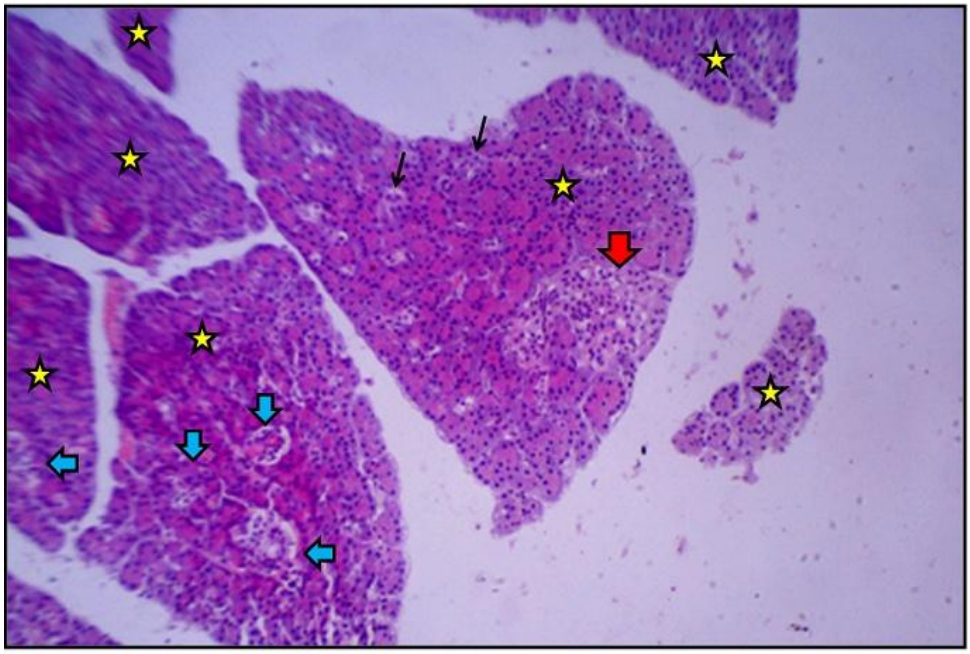

Fig. 14. Left lobe of pancreas of adult cat. It showed large (red arrow), medium (blue arrows) and small (black arrows) Islet's of Langerhans present in pancreatic lobules (yellow stars). H&E, X100

Table 1. Macromorphometric measurements (Mean ± SE) of pancreas of domestic cats at different postnatal ages.

Age of Animal	Parameters	Left Lobe	Right Lobe
One week	Length (cm)	3.1±0.02 SE	4.5±0.11SE
	Relative length	40.79%	59.21%
	Weight (gm)	0.02±0.32 SE	0.04±0.03 SE
	Relative weight	33.33%	66.67%
4 weeks	Length (cm)	8.2±0.03 SE	10.3±0.07 SE
	Relative length	44.32%	55.68%
	Weight (gm)	4.6±0.01 SE	6.7±0.04 SE
	Relative weight	40.71%	59.29%
Adult	Length (cm)	8.6±0.01 SE	11.3±0.023 SE
	Relative length	43.21%	56.78%
	Weight (gm)	8.13±0.07 SE	12.06±0.22 SE
	Relative weight	40.26%	59.73%

SE: slandered error

Table 2. Percentage of parenchyma tissue to whole pancreatic tissue per 1 mm^2 at different post-natal ages.

Ages	percentage of parenchyma tissue / Whole tissue of right lobe	percentage of parenchyma tissue / Whole tissue of left lobe	percentage of parenchyma tissue / Whole tissue of body	percentage of parenchyma tissue / Whole tissue of pancreas
One week	52.33%	55.21%	55.25%	54.26 %
4 weeks	78.01%	79.13%	78.87%	78.67% *
Adult	80.84%	82.26%	81.01%	81.37% *#

* Significantly (P<0.05) different compared to those of one week of age
# Not significant (P>0.05) differences between 4 weeks and adult ages

Table 3. Densities of islets per each mm^2 to whole pancreatic tissue at different post-natal ages

Ages	Mean of islets number /mm^2 right lobe	Mean of islets number /mm^2 Left lobe	Mean of islet number /mm^2 body	Means of islet number /mm^2 of whole pancreas
One week	0.34	0.36	0.35	0.35
4 weeks	2.10	2.48	2.32	2.30*
Adult	2.38	2.79	2.39	2.52*#

* Significantly (P < 0.05) higher density compared with the one week of age
# Not significantly (P > 0.05) higher density of 4 weeks compared with the adult

Table 4. Percentages of α, β and δ to the sum of Islet's cells at different post-natal ages

ages	Percentage of α to sum of β, α & δ	Percentage of β to sum of β, α & δ	Percentage of δ to sum of β, α & δ
One week	59% *	40%	1%
4 weeks	51.78	47.62%	0.60%
Adult	26.88%	72.72 % #	0.40%

* Significantly (P < 0.05) higher percentage of α at one week compared to 4 weeks and adult
# Significantly (P < 0.05) higher percentage of β at adult compared to 1 week and 4 weeks

Conclusions:

It could be concluded that pancreas in domestic cat was not fully developed at birth and the organ showed developmental morphological changes promptly post 4 weeks of age. The current findings can be categorized into two criteria. First of all, attention should be taken by both owners of cats and veterinarians on the management and feeding program particularly post weaning period of the animals to avoid nutritional diseases and insure their vaccine programs and subsequently caused animals raised with well health condition. The second criteria, as the

pancreas of the cats showed morphological similarities to those of human so that we can consider cats a good model or voluntaries to conduct pharmaco-physiological attempts against some diseases such as diabetes mellitus.

Contributions:-

1. Both authors conducted all practical portion of the article.
2. Corresponding author examined the slides, wrote the findings and conducted the statistical aspect of the article.
3. Both authors conducted the gross and microscopic photography.

Conflict of Interests:-

The authors have not declared any conflict of interests.

Acknowledgement:-

The authors strongly acknowledge the council of the Veterinary Medicine College/Baghdad University to support this research project

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