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MACROSCOPIC ANATOMY OF PANCREAS IN RATS, GUINEA PIGS, CHINCHILLAS AND RABBITS

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Abstract

The aim of this paper is to provide a detailed and comparative presentation of macroscopic anatomy of the pancreas, its topography and connection elements among the experimental animal species including rats, guinea pigs, chinchillas and rabbits. Using gross dissection, the pancreas and its connection elements were studied on 10 specimens of each species presented. The triangular form of the pancreas is a common anatomical pattern in rats, guinea pigs and chinchilla with different degrees of development of the three portions. Located reroperitoneally and in relation to the duodenum, spleen and stomach, the three portions are referred as the duodenal, splenic and gastric portion or lobes with the same names. In rabbits, however, the right lobe of the pancreas has a diffuse appearance, being located largely in the mesoduoden compared to the left lobe which has a better defined shape being located in the deep wall of the greater omentum. The pancreas relations in the experimental models studied are with the right lobe of the liver, the portal vein, the right kidney, the caudal cava vein, the aorta and the emergence of the celiac and mesenteric arteries, the profound wall of the large omentum, the stomach and the transverse colon.

Key words*: pancreas, anatomy, experimental models.*

INTRODUCTION

Over the decades, the pancreas in experimental animals was intensively studied related to its physiological component. Since the insulin discovery in 1921 and its direct relationship with the glucose metabolism followed by the research involving the inflammatory, ischemic and neoplastic morbidities, it was clearly stated the need of experimental models in order to achieve a better understanding of local and systemic organic implications (Aghdassi et al., 2011; Cattley et al., 2013; Stan 2014; 2015; 2017). Moreover, pancreatic transplantation required a proper knowledge of pancreas anatomy in experimental animals in order to improve surgical techniques. With the exception of domestic animals, in which the pancreas has been extensively studied, both macroscopically and microscopically, detailed anatomical studies were performed in mouse, rats, monkeys, dogs and minipigs (Suckow et al., 2012; Pandiri, 2014; Tsuchitani et al., 2016). In this study, it was intended to present detailed description about the macroscopic anatomy of the pancreas and especially to emphasize the difference and similarities of pancreatic macroscopic anatomy in the rats, chinchillas, guinea pigs and rabbits, which may guide researchers in experimental studies.

MATERIALS AND METHODS

Ten healthy adult rats, guinea pigs, chinchillas and rabbits were used. The Institutional Bioethics Committee of University of Agricultural Science and Veterinary Medicine in accordance to Directive 2010/63 /EU of the European Parliament and of the Council on the protection of animals used for scientific purposes approved the study. Euthanasia was performed by administration of an overdose of isoflurane. The abdominal cavity was opened and the wall of it were carefully removed in order to visualize and to photograph the pancreas, its relations with the adjacent organs and its connection elements. The pancreas was divided in the following portions: duodenal segment, gastric segment and splenic segment. The duodenal segment was visualized ventrally with a minor procedure as pulling the duodenum caudally and additionally the entire pancreas were reached dorsally since the stomach and spleen were turned cranially.

Terms were used in agreement with the NAV (Nomina Anatomica Veterinaria) 2012.

RESULTS AND DISCUSSIONS

Rat

The pancreas has a lobulated pattern. On the right side it was located in the mesentery of the duodenal loop and transverse colon extending to the dorsal part of greater omentum adjacent to the stomach and spleen (Figure 1).

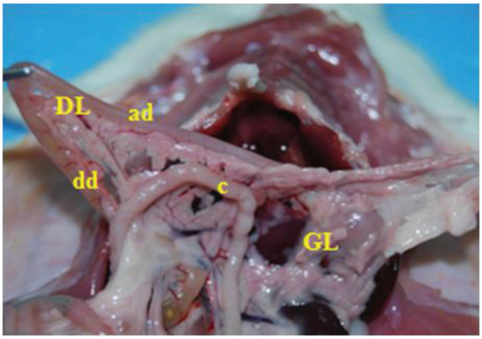

Figure 1. The duodenal lobe – DL of pancreas in rats located in the mesoduodenum. The gastric lobe – GL extends into the dorsal sheet of the greater omentum. dd – descending duodenum; ad – ascending duodenum; c – colon.

On the right side, the right lobe of pancreas (*Lobus pancreatis dexter*) or duodenal lobe was invested in the mesentery between the descending and ascending ansa of the duodenum (*Mesoduodenum*). The splenic lobe, (Figure 2) extends from the duodenal lobe toward to the spleen on the left side of the median plane, being the left lobe correspondent (*Lobus pancreatis sinister*).

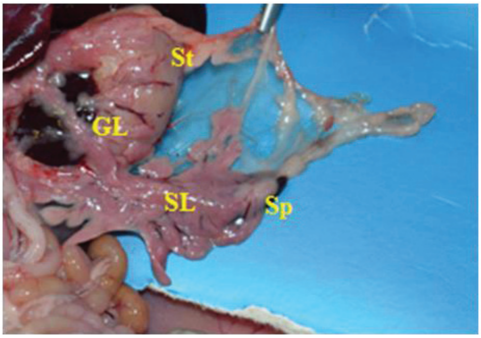

Figure 2. The splenic lobe – SL of pancreas in rats is the most developed and compact lobe. It extends between the duodenal lobe and spleen - Sp. GL – gastric lobe; St – stomach.

It was the most developed and compact lobe of the pancreas in rats. The terminal part of the splenic lobe extends into the gastrosplenic ligament (*Lig. gastrolienale*) (Figure 3).

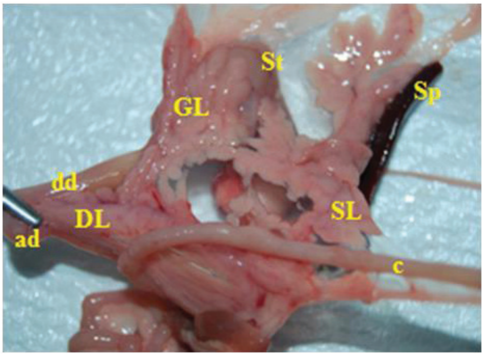

Figure 3. The three lobes compound pancreas in rat: The duodenal lobe – DL; the gastric lobe – GL; the splenic lobe – SL. The caudal part of the duodenal lobe and the dorsal part of the splenic lobe are joined together near to the colon – c.

The gastric lobe was the smallest lobe of the pancreas in rats, extending from the left portion of the duodenal lobe into the dorsal sheet of the greater omentum adjacent to the stomach.

Guinea pig

The pancreas in guinea pig consists of three lobes, each lobe being separated into a number of small lobules. The duodenal lobe lies in close contact with the descending duodenum into the mesentery between the ascending and descending duodenum (Figure 4).

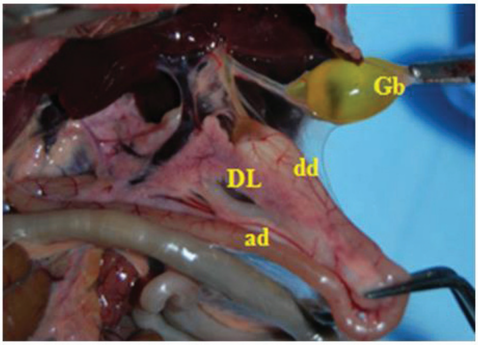

Figure 4. In guinea pig, the duodenal lobe – DL lies in close contact with descending duodenum – dd, into the mesentery between the descendant and ascendant – ad ansa of the duodenum. Gb – gallbladder.

From the proximal portion of the duodenal lobe, the splenic lobe extends to the left, in a caudal direction, near to the dorsal part of the spleen. The compact splenic lobe was the largest lobe of pancreas in guinea pig being fully attached to the gastrosplenic ligament (Figure 5).

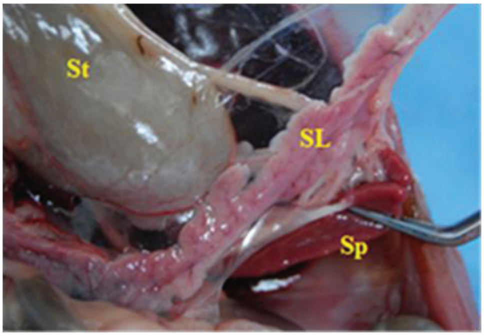

Figure 5. The splenic lobe - SL of pancreas in guinea pig extends caudally to the stomach – St, to the left on the dorsal aspect of the spleen – Sp.

Several islets of pancreatic tissue arranged in a dendritic manner caudally to the fundus of the stomach, and detached from the splenic lobe, formed the gastric lobe of pancreas in guinea pigs (Figure 6).

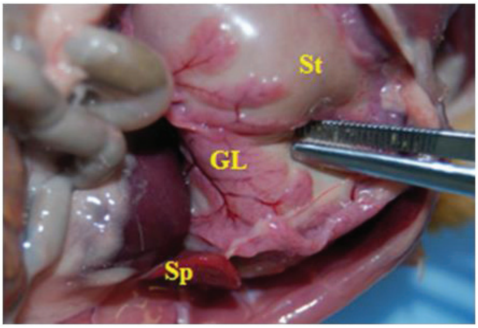

Figure 6. The gastric lobe – GL of pancreas in guinea pig arranged in a dendritic manner caudally to the stomach - St. Sp – spleen.

Chinchilla

In situ the pancreas showed the same three divisions: the duodenal lobe, the splenic lobe and the gastric lobe. The duodenal lobe, corresponding to the right lobe of pancreas (*Lobus pancreatis dexter*) was located adjacent to the duodenum, being attached to the descending loop of duodenum (Figure 7).

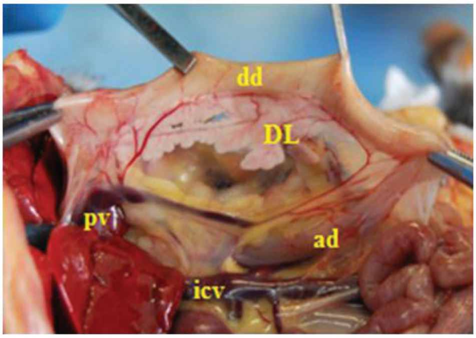

Figure 7. The well defined duodenal lobe – DL of pancreas in chinchilla lies in contact with descending duodenum – dd. The portal vein – pv, passes in close proximity of the caudal portion of the duodenal lobe. icv – inferior cava vein.

Its length does not reach the transverse portion of the duodenum and is not in contact with the ascending loop.

The portal vein was in close proximity to the caudal portion of the duodenal lobe. The left lobe (*Lobus pancreatis sinister*) or splenic lobe has a compact appearance exceeding the caudal edge of the spleen (Figure 8).

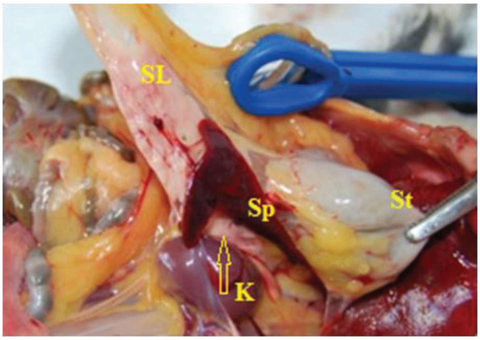

Figure 8. The left lobe of pancreas – SL in chinchilla has a compact appearance exceeding the caudal edge of the spleen - arrow. K –left kidney; St – stomach.

The gastric lobe was dispersed in multiple nodules protruding toward to the stomach (Figure 9). In chinchilla, the pancreas has a triangular shape with irregular margins after removal from the abdominal cavity (Figure 9).

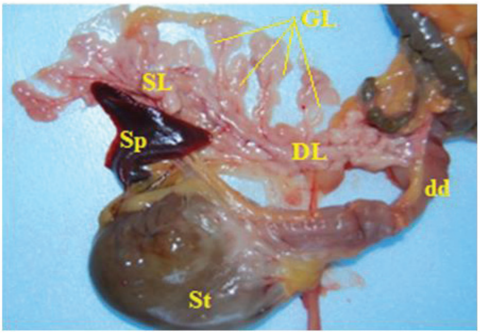

Figure 9. The triangular shape of the chinchillas pancreas. The splenic lobe – SL, was the most developed and compact lobe. The gastric lobe – GL, was dispersed in small portions protruding to the stomach – St. Sp – spleen; dd – descending duodenum.

Rabbit

The major part of the rabbit pancreas is contained into the mesoduodenum, this part being correspondent of the right lobe of pancreas or duodenal lobe (Figure 10).

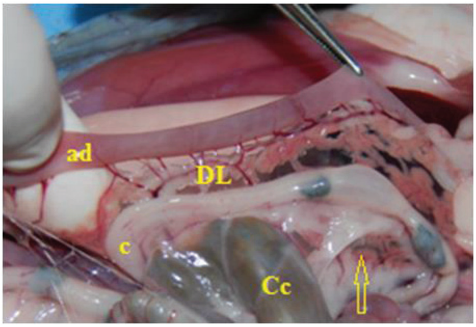

Figure 10. In rabbits, the diseminated glandular tissue of pancreas into the mesoduodenum – DL and arrow, is correspondent of the duodenal lobe. ad – ascending duodenum; c- colon; Cc – cecum.

It appears as a diffused irregular mass of glandular tissue distributed around the pancreatico-duodenal blood vessels and in more close relationship to the ascending ansa of the duodenum (Figure 10). On the lesser curvature of the stomach, and cranial part of the duodenum the gastric lobe was identified. This portion has a slightly condensed appearance (Figure 11).

The left lobe (*Lobus pancreatis sinister*) of the pancreas in rabbits located caudally from the stomach fundus into the wall of greater omentum and in close contact with spleen was assessed as the splenic lobe (Figure 12). This lobe reaches up to the ventral aspect of the left kidney.

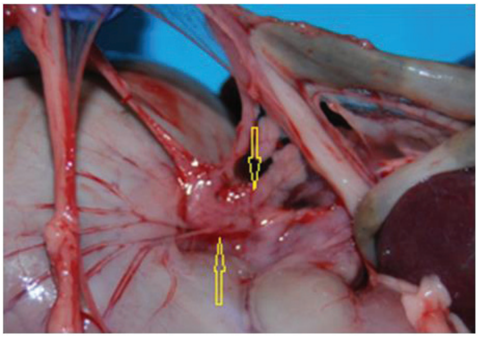

Figure 11. Slightly condensed appearance of pancreatic tissue – arrows, bounded by the lesser curvature of the stomach and cranial part of the duodenum, corresponding of the gastric lobe of pancreas in rabbit.

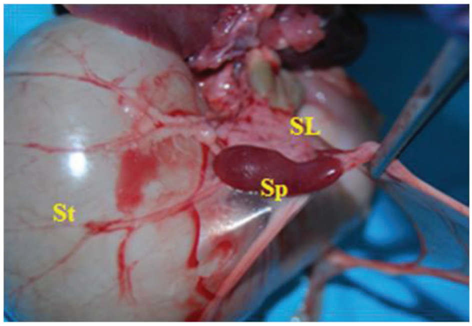

Figure 12. The condensed portion of the left pancreas in rabbits was the splenic lobe –SL. It was extended between the two extremities of the spleen – Sp and the stomach – St.

Due to the fact that pancreas is a target of a numerous diseases, from which the pancreatic cancer and diabetes mellitus are of major importance, this organ is of a great importance both of morphological and clinical interest. Several laboratory animals have been used in a numerous toxicological, pharmacological (Pandiri 2014; Stan 2015) and surgical researches in order to increase the knowledge which can be applied in humans and domestic animals. In this regard, rodents and rabbits are considered good models in clinical and anatomical studies of diverse morphological abnormalities and pancreatic disease (Aghdassi et al., 2011; Stan 2015; 2017; Tsuchitani et al., 2016).

Compared to the human pancreas, which is a compact organ, in experimental animals, the pancreas has a different appearance. Generally, two types of macroscopic anatomy is recognized: a diffuse pattern in which islets of glandular pancreatic tissue are diffusely distributed into the mesentery between the duodenal loop, found in rabbits (Barone 1997; Brewer 2006) and a more compact appearance found in domestic animals, monkeys, minipig and humans (Swindler et al,. 1973; Barone 1997; Evans and de Lahunta, 2013; Tsuchitani et al., 2016). In experimental animals there is an intermediate pattern in which the diffused distribution of the duodenal lobe alternate with a more compact pattern of the left portion (Barone 1997; Katherine Quesenberry and Carpenter 2012; Stan 2017). This is in agreement with our results which showed a compact appearance of the left portion of the pancreas in rats, guinea pigs, chinchillas and in the rabbits. Regarding the right portion assessed as right lobe or duodenal lobe, the diffused pattern of this lobe was the most pronounced in rabbits, while in guinea pigs, rats and chinchillas, the glandular tissue was compact and organized. A possible explanation of this feature is due to the large mobility of the duodenum found in rabbits.

In veterinary medicine and in accordance with the anatomical denomination (NAV) the pancreas is composed by the right and left lobe united through the body. More recent description in experimental animals uses different terms for lobe denomination like duodenal, gastric and splenic lobes (Stan 2017) or gastric lobe, duodenal head and tail (Cattley et al., 2013). In this study for a better comprehension of the macroscopic anatomy the same terms were used. Moreover, these terms have been used because the pancreas portions to which they refer are named after the organs they are in relation with. Therefore, the duodenal lobe was the correspondent of the right lobe of the pancreas or head of the pancreas. In rats, some authors have described the head of the pancreas being composed by the duodenal and parabilliary portion (Tsuchitani et al., 2016). We did not use the parabilliary terms because our results showed that the right lobe was invested into the mesentery between the ascending and descending loop of duodenum at equal distance from the two loops. The gastric lobe described in this study as in the cited literature, has no counterpart in the domestic larger species. In the human, the terms head, neck, body and tail are used to name the different regions of the pancreas. Taking into consideration the anatomical description of pancreas in humans (composed by the head, body and tail), in species presented here, the body of the pancreas extends from the head to the stomach and spleen. In this regard the gastric and proximal part of the splenic lobe is correspondent of the body of the pancreas in the mentioned species. Even in rabbit we showed the presence of a well defined gastric lobe disposed between the lesser curvature of the stomach and spleen, feature founded in other description too (Al-Saffar and Al-Hasnawy, 2014). The compact splenic lobe was found in all species of this study, being the largest lobe in rats, guinea pigs and chinchilla, as it was mentioned in other descriptions (Suckow et al., 2012; Wagner, 2014;). In rabbit this lobe was compact but regarding its length it was shorter than the duodenal lobe. In chinchilla, due to the particular triangular shape of the spleen, the splenic lobe of pancreas, especially the caudal part accounting to the tail of the pancreas, exceed the caudal part of the spleen. This pattern was mentioned by other authors too (Campbell-Ward, 2012; Ozdemir et al., 2013).

Similar with other description of pancreas in Rodents and rabbits (Katherine E. Quesenberry, and Carpenter, 2012; Al-Saffar and Al-Hasnawy, 2014; Wagner 2014), our study highlighted the pancreas partial location into the peritoneum folds between the duodenum, stomach and transverse colon, and partly location between the stomach, spleen, pancreatico-duodenal and splenic vessels. The close relation with the major vessels is of major importance in surgical experiments (Stan 2015). In this regard is worth to be mentioned the ring shape of the body of the pancreas found in a common experimental animal – the minipig. The body of the pancreas in this specie is composed of two separate portions that encompass the portal vein and make the pancreas appear to be „ring-shaped" (Ferrer et al., 2008). This patern is present in horse, pig and sometimes in cattle (Barone 1997). In the species that were the subject of this study, we have not met this feature.

The macroscopic description of pancreas anatomy is important from the point of view of physiological, pathological and surgical studies. Experimental induction of diabetes, pancreatitis, or transplantation of pancreatic islets should take into account the segmental division of the pancreas in rodents and rabbits as it was shown in this study, the three lobe compound pancreas; the close relationship with the major vessels and the care not to injure the anatomical structure as pancreatic ducts and biliary ducts.

Due to the fact that the present study it was performed on four species, the vascular anatomy of the pancreas and the pancreatic ducts description are subjects of future reports.

CONCLUSIONS

In rats, guinea pigs, chinchillas and rabbit the pancreas presented three well-differentiated portions or lobes. These lobes have been named in relation to adjacent organs: duodenal, gastric and splenic lobe. Related to the human denomination the duodenal lobe is the head of pancreas correspondent; the gastric and the proximal part of the splenic lobe is the correspondent of the body of the pancreas and the caudal portion of the splenic lobe is the tail of pancreas correspondent.

REFERENCES

Aghdassi AA, Mayerle J, Christochowitz S, Weiss Sendler M, and Lerch MM. 2011. Animal models for investigating chronic pancreatitis. Fibrogenesis Tissue Repair. 4: 26.

Al-Saffar F.J. and A.H.A. Al-Hasnawy, 2014. Histomorphological Developmental Study of Advanced Postnatal of the Pancreas of Local Rabbit. Journal of Biological Sciences, 14: 387-402.

Barrone, R.. 1997. Anatomie comparée des mamiferes domestique, Tome III, Spanchnologie, Appareil digestif, Appareil respiratoire, Ed.Vigot, Paris.

Brewer N. 2006. Biology of the rabbit. J Am Assoc Lab Anim Sci 45:8–24

Swindler DR, and Wood CD. Abdomen. Pancreas, Duodenum,and Superior Mesenteric Artery. In: An Atlas of Primate Gross Anatomy: Baboon, Chimpanzee, and Man. DR Swindler and CD Wood (eds). University of Washington Press, Seattle. 214–215. 1973.

Campbell-Ward M. L. 2012. Gastrointestinal physiology and nutrition. pp. 183–192. *In*: Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery, 3rd ed. (Quesenberry, K. E. and Carpenter, J. W. eds.), Elsevier, St. Louis.

Cattley RC, Popp JA, and Vonderfecht SL. 2013. Liver, Gallbladder, and Exocrine Pancreas. Exocrine Pancreas. In: Toxicologic Pathology: Nonclinical Safety Assessment. PS Sahota, JA Popp, JF Hardisty, and C Gopinath (eds). CRC Press, Boca Raton. 345–356..

Evans Howard E. and de Lahunta Alexander, 2013. Miller's Anatomy of the Dog, 4th Edition, Saunders, Elsevier Inc.

Ferrer J, Scott WE 3rd, Weegman BP, Suszynski TM, Sutherland DER, Hering BJ, and Papas KK. 2008. Pig pancreas anatomy: implications for pancreas procurement, preservation, and islet isolation. Transplantation. 86: 1503–1510..

Katherine E. Quesenberry, J. W. Carpenter, 2012. Ferrets, Rabbits and Rodents, Clinical Medicine and Surgery, Third Edition,Saunders Elsevier, Missouri.

NAV fifth edition 2012.

Özdemir V., Çevik Demirkan A., Akosman M. S. 2013. Subgross and macroscopic investigation of the coeliac artery in the chinchilla *(Chinchilla lanigera).* Folia Morphol. (Warsz) *7*2: 258–262.

Pandiri, A. R. 2014. Overview of Exocrine Pancreatic Pathobiology. Toxicologic Pathology, 42(1), 207–216

Stan, F. 2014. Anatomical Particularities of the Cecum in Rabbits and Chinchillas. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Veterinary Medicine, 71*(2),* 406-412.

Stan, F. 2015. Rabbits and chinchillas as experimental models. Lucrări Științifice. Seria Medicină Veterinară. Iași, Partea I, , vol 58, p 90-98.

Stan, F. 2014. Topographical anatomy of guinea pigs kidneys. Lucrări Ştiinţifice Medicină Veterinară Timişoara, Vol. XlVII(1), 114-123.

Stan, F., 2017. Anatomical differences and similarities of the pancreas in Guinea Pig (*Cavia porcellus*) and Domestic Rabbit (*Oryctolagus cuniculus*) Lucrări Ştiinţifice Medicina Veterinară Vol. L (2), 355-363 Timişoara

Suckow, M.A., Karla A. Stevens, R. P. Wilson, , 2012. The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents, First edition, Saunders Elsevier.

Tsuchitani, M., Sato, J., & Kokoshima, H. 2016. A comparison of the anatomical structure of the pancreas in experimental animals. Journal of Toxicologic Pathology, , 29(3), 147–154.

Wagner Joseph E. 2014. The Biology of the Guinea Pig American College of Laboratory Animal Medicine Academic Press, 317 pag.

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