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Microscopic Focus on the Different Hepatic Cells of The Young Domesticated Pig (*Sus suidae*)

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ABSTRACT

The current investigation was concerned with the different hepatic cells of the liver of the young domesticated pig. This work was carried out on fresh hepatic specimens from six healthy young pigs that were gathered immediately after their slaughter at the Abdelkader abattoir, Alexandria, Egypt. In our histological results, the liver had different cells including the hepatocytes and non-parenchymal cells including, the Kupffer cells and Ito cells. The hepatocytes had a large round cell nucleus with a prominent nucleolus. The intracellular lipid droplets allowed for the identification of ito cells and were found in the perisinusoidal space**.** By TEM observations, Kupffer cells had an irregular nucleus with a condensed type of chromatin**.** Ito cells had a large flat nucleus and large fat droplets, while their cytoplasm had a rough endoplasmic reticulum intermixed with mitochondria.

1. INTRODUCTION

The omnivorous domesticated pig (*Sus Suidae*) belongs to order *Artiodactyla*, family *Suidae*, and genus *Sus*. The omnivorous domesticated pigs are bred mostly for meat consumption, and they feed on plants and occasionally feeding on insects and fish (Kongsted et al., 2013).

Anatomically, the liver is the largest internal organ, with detoxifying, immunologic, metabolic, and synthetic processes among its many responsibilities. A unique hepatic advantage is that its different cells, including the hepatocytes, can perform both exocrine and endocrine functions, which is different from the pancreas where the two functions are performed by different pancreatic cells (Radu-Ionita et al., 2020). The liver performs an exocrine role, such as any gland. Moreover, its endocrine roles include hormonal secretion such as Insulin-like growth factors, angiotensinogen, and thrombopoietin (Radu-Ionita et al., 2020).

Hepatocytes, which are parenchymal cells, and non-parenchymal cells, such as Ito, Kupffer, and sinusoidal endothelial cells, as well as other cell types that are established in the sinusoidal compartment, are present in the mammalian liver (Kmiec, 2001; Malarkey et al., 2005). The Kupffer cell is an essential fixed hepatic macrophages and related to the immune system (Kiki et al., 2007; Naito et al., 2004). The stellate hepatic cells are named Ito cells or fat-storing cells, lipocytes (Senoo, 2007). In brief, both Ito and Kupffer cells have an important function in the event of some hepatic neurotic conditions, while, amazingly, the histochemical and immunohistochemical parts of both these cell types are well identified known as far as their correlation to obsessive as opposed to ordinary conditions.

The most available published articles focused on the microscopic structure of the liver in the adult animal. Additionally, there is scanty information about the description of the liver in young animals, especially the domesticated pig. Wherefore, the present study focused on the description of the histological and transmission electron microscopic features of the liver in the young domesticated pig (*Sus Suidae*). Finally, the current results were matched with the formerly published information on the young and adult animals.

2. MATERIAL AND METHODS

2.1. Sample's collection

Fresh hepatic specimens from six healthy two-month-old, domesticated pigs were gathered after their slaughter at the Abdelkader abattoir, Alexandria, Egypt. Since these animals were being slaughtered for human consumption, and the slaughterhouse veterinarian had to approve their use before the animals were slaughtered. The present investigation was prepared according to the guidelines for using and caring for the laboratory animals and followed the animal Ethics and welfare in the Faculty of Veterinary Medicine, Alexandria University, and according to Egyptian's laws.

2.2. Transmission electron microscopy (TEM) description

Fresh 1 mm thickness samples from hepatic tissue were taken, preserved in a solution of 2.5% glutaraldehyde for 24 h at 4 ℃, rinsed in 0.1 M cacodylate buffer at pH 7.4, and post-fixed for 1 h at room temperature with 1% osmium tetroxide. After that, the samples were kept at 4 ºC in a washing solution of 0.1 M sodium cacodylate had 5% sucrose, processed by the tannic acid. Samples were dehydrated with ethyl alcohol in a graded sequence and eventually embedded in epoxy resin (Hayat, 1986). For tissue examination, serial semithin sections were cut and stained with toluidine blue (Stockert & Colman, 1978). Toluidine blue staining on Epon semithin sections were examined by the light microscope. Ultrathin sections (50-60 µm) were cut and stained with uranyl acetate dihydrate and lead citrate saturated solution (Bozzola & Russell, 1999). Finally, the sections were photographed by JEOL JEM-2100 TEM at the Faculty of Science, Alexandria University, Egypt.

2.3. Digital coloring of transmission electron microscopic images

We digitally colored the transmission electron microscopic images using the Photo Filter 6.3.2 program to illustrate the different structures according to (Elghoul et al., 2022; Kandyel et al., 2022; Roshdy et al., 2021) have applied this method.

3. RESULTS

3.1. Histological findings:

Our histological findings for semithin sections demonstrated that the liver of the young-domesticated pig (*Sus Suidae)* is composed of several different parenchymal cells including the hepatocytes and the non-parenchymal cells, including the Kupffer cells (specialized hepatic macrophages), Ito cells (stellate liver cells or fat-storing cells), bile duct epithelium, and leukocytes. These cells were arranged into cords and separated by the hepatic blood sinusoids, which were lined by discontinuous endothelial cells (Fig.1A). The hepatocytes show a typical large round centrally located nucleus with a prominent nucleolus. The intracellular lipid droplets allowed for the identification of ito cells at the perisinusoidal space (Fig.1B).

3.2. Transmission electron microscope results

By the transmission electron observations, Kupffer cells were found either near the endothelial lining or as a part of the blood sinusoid. Kupffer cells were characterized by an irregular nucleus with a condensed type of chromatin (Fig.2A). The perisinusoidal space that named the space of Disse was faced the microvillus surface of the liver hepatocytes (Fig.2B-C). The space of Disse contained stellate liver cells or fat storing (lipocytes) cells that were known as the Ito cells, and this space had reticular fibers, and nerves. Moreover, the Ito cells were characterized by the presence of a large, flat nucleus having abundant cytoplasmic fat-droplets (Fig.2B). The cytoplasm of Ito cell showed a normal rough endoplasmic reticulum encircling the nucleus, as well as numerous scattered mitochondria with visible cristae (Fig.2B-D).

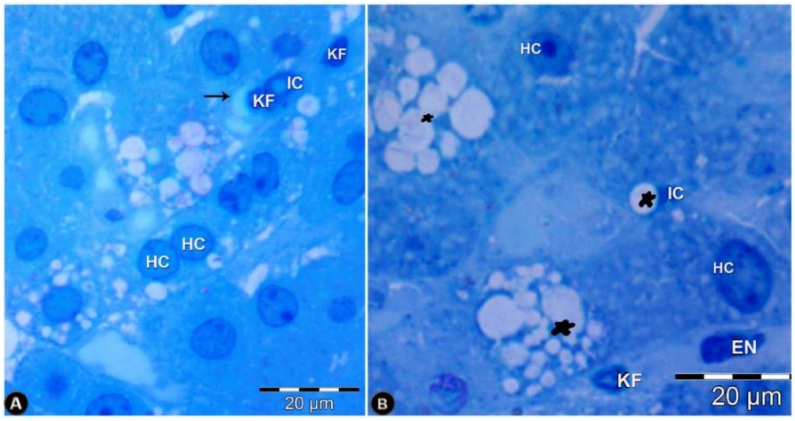

Figure 1: Photomicrograph of the liver of the young-domesticated pig (*Sus Suidae*) showing; the different hepatocytes (**HC**), Kupffer's cells (**KF**), and Ito's cells (**IC**). Note the presence of the blood sinusoid (**black arrow**), lipid droplets distributions (**Asterisks**), endothelial lining of the blood sinusoid (**EN**). ***Toluidine blue stain (X 400).***

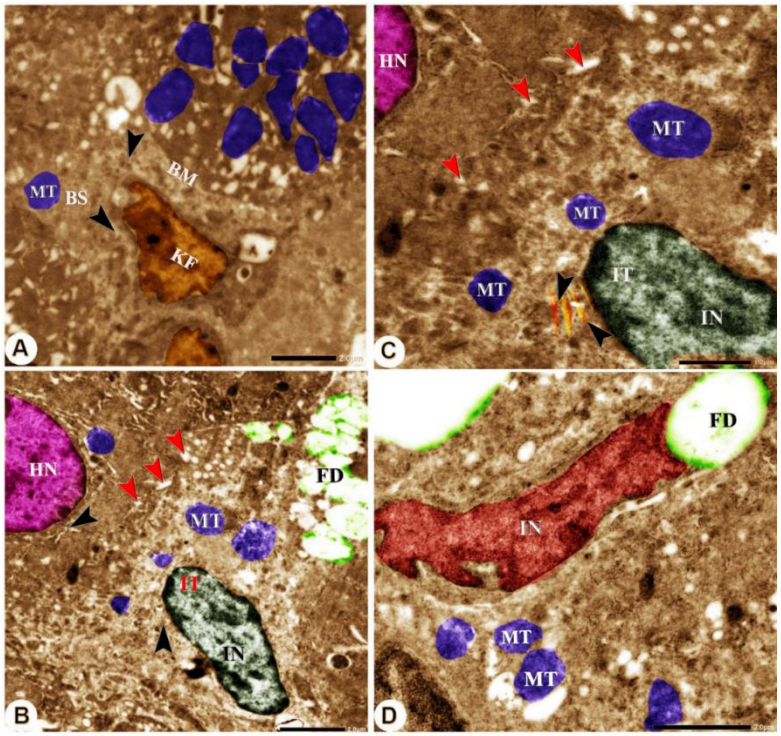

Figure 2: Transmission electron micrograph of the liver of the young-domesticated pig (*Sus Suidae*) showing: (View A) denoting Kupffer's cell (KF) inside the blood sinusoid (BS), the basement membrane of the blood sinusoid (BM), and mitochondria (MT). ***(X 3000).*** **(View B)** showing hepatocyte nucleus (HN), Ito cells (IT) with its nucleus (IN), rough endoplasmic reticulum (black arrowheads), the perisinusoidal space or space of Disse (red arrowheads) and fat droplet (FD), mitochondria (MT). ***(X 3000)***. **(View C)** showing hepatocyte nucleus (HN), Ito cells (IT) with their nucleus (IN), rough endoplasmic reticulum (black arrowheads), the red arrowheads refer to the perisinusoidal space or space of Disse, and mitochondria (MT). ***(X 6000)***. **(View D)** showing the nucleus of Ito cells (IN) with stored fat-droplets (FD), and mitochondria (MT). ***(X 6000).***

4. DISCUSSION

The mammalian liver is composed of non-parenchymal cells such as Ito, Kupffer, and sinusoidal endothelial cells, as well as other cell types that are developed in the sinusoidal compartment, in addition to parenchymal cells (hepatocytes) (Ahmed et al., 2015; Carollo et al., 2012; Kmiec, 2001; Malarkey et al., 2005; Robert, 2004; Sasan et al., 2017). Our histological investigations agreed with (Cullen & Stalker, 2016; Jennings et al., 2017; Malik & Prakash, 1977) that the liver of the young-domesticated pig (*Sus Suidae)* is composed of several different parenchymal cells, including the hepatocytes and the non-parenchymal

cells including the Kupffer cells (liver macrophages), Ito cells (stellate liver cells or fat-storing cells), bile duct epithelium, and leukocytes.

The current histological findings revealed that the hepatocytes had a typical large round centrally located nucleus with a prominent nucleolus, similar results were reported by (Carollo et al., 2012; Cullen & Stalker, 2016; Jennings et al., 2017). The current transmission electron observations revealed that the Kupffer cells were found either near the endothelial lining or found as a part of the blood sinusoid, similar results were reported by (Cullen & Stalker, 2016; Jennings et al., 2017). The current study agreed with (Carollo et al., 2012; Cullen & Stalker, 2016; Jennings et al., 2017) that the Kupffer cells are the fixed hepatic macrophages, so this arrangement facilitates phagocytic particulate elimination, particularly bacteria that enter the portal blood through the digestive system.

Kupffer cells represent the intrasinusoidal resident macrophages of the liver. Their primary role includes phagocytosis of foreign bodies such as dead and foreign cells, foreign particles, and infectious agents (Decker, 1990; Wisse et al., 1996). Furthermore, Kupffer cells can present antigens to lymphocytes and play a crucial role in tissue repair by removing damaged tissues (Kmiec, 2001).

The sinusoids are separated from the neighboring hepatocellular plates by means of extracellular space named perisinusoidal space or space of Disse. The current transmission electron observations revealed that the space of Disse was faced the microvillus surface of the liver hepatocytes, similar results were reported by (Carollo et al., 2012; Cullen & Stalker, 2016; Jennings et al., 2017). The current transmission electron observations revealed that the space of Disse contained stellate liver cells or fat storing (lipocytes) cells named Ito cells, characterized by the presence of a large flat nucleus and a large fat-droplets and their cytoplasm had a rough endoplasmic reticulum intermixed with mitochondria, similar results were reported by (Carollo et al., 2012; Cullen & Stalker, 2016; Hautekeete & Geerts, 1997; Jennings et al., 2017; Senoo, 2007).

Conclusion

The liver had different cells, including the hepatocytes and non-parenchymal cells, including the Kupffer cells and Ito cells. The hepatocytes had a large round cell nucleus with a prominent nucleolus. Ito cells were identified by the presence of a large flat nucleus and a large fat-droplets, while their cytoplasm had a rough endoplasmic reticulum intermixed with mitochondria**.**

Data Availability Statement: Research data are not shared

Conflict of interest: None

REFERENCES

Ahmed, R. S., Abdalla, A. B., & Ismail, H. 2015. Some Histochemical and Morphometric Observations on the Liver of the Dromedary Camel (Camelus dromedarius). *Global Journal of Animal Scientific Research, 3*(2): 503-511.

Bozzola, J. J., & Russell, L. D. (1999). *Electron microscopy: principles and techniques for biologists*: Jones & Bartlett Learning.

Carollo, V., Di Giancamillo, A., Vitari, F., Schneider, R., & Domeneghini, C. 2012. Immunohistochemical aspects of Ito and Kupffer cells in the liver of domesticated and wild ruminants.

Cullen, J. M., & Stalker, M. J. 2016. Liver and biliary system. *Jubb, Kennedy & Palmer's Pathology of Domestic Animals: Volume 2*: 258.

Decker, K. 1990. Biologically active products of stimulated liver macrophages (Kupffer cells). *European Journal of Biochemistry, 192*(2): 245-261.

Elghoul, M., Zaghloul, D., Morsy, K., & Abumandour, M. M. A. 2022. Cellular architecture of the testis of Egyptian wild boar (Sus Scrofa) in young and adult age. *Microsc Res Tech, 85*(6): 2076–2082.

Hautekeete, M. L., & Geerts, A. 1997. The hepatic stellate (Ito) cell: its role in human liver disease. *Virchows Archiv, 430*(3): 195-207.

Hayat, M. (1986). *Basic Techniques for Transmission Electron Microscopy. 2nd Edn., Academic Press, Baltimore.*

Jennings, R., Premanandan, C., Cianciol, R., Wilkie, D., Wong, A., & Kendziorski, J. (2017). *Veterinary histology*: Ohio State University Libraries.

Kandyel, R. M., El Basyouny, H. A., El Nahas, E. E., Madkour, F., Haddad, S., Massoud, D., . . . Abumandour, M. M. A. 2022. A histological and immunohistochemical study on the parabronchial epithelium of the domestic fowl's (Gallus gallus domesticus) lung with special reference to its scanning and transmission electron microscopic characteristics. *Microscopy research and technique, 85*(3): 1108–1119

Kiki, I., Altunkaynak, B. Z., Altunkaynak, M. E., Vuraler, O., Unal, D., & Kaplan, S. 2007. Effect of high fat diet on the volume of liver and quantitative feature of Kupffer cells in the female rat: a stereological and ultrastructural study. *Obesity surgery, 17*(10): 1381-1388.

Kmiec, Z. (2001). *Cooperation of liver cells in health and disease: with 18 tables*: Springer-Verlag Berlin Heidelberg.

Kongsted, A. G., Horsted, K., & Hermansen, J. E. 2013. Free-range pigs foraging on Jerusalem artichokes

(Helianthus tuberosus L.)–effect of feeding strategy on growth, feed conversion and animal behaviour. *Acta Agriculturae Scandinavica, Section A–Animal Science, 63*(2): 76-83.

Malarkey, D. E., Johnson, K., Ryan, L., Boorman, G., & Maronpot, R. R. 2005. New insights into functional aspects of liver morphology. *Toxicologic pathology, 33*(1): 27-34.

Malik, M., & Prakash, P. 1977. A quantitative histological study of the abomasum of buffalo (Bubalus bubalis) and ox (Bos indicus)[dairy cattle, India]. *Indian Journal of Animal Sciences (India)*.

Naito, M., Hasegawa, G., Ebe, Y., & Yamamoto, T. 2004. Differentiation and function of Kupffer cells. *Medical Electron Microscopy, 37*(1): 16-28.

Radu-Ionita, F., Pyrsopoulos, N. T., Jinga, M., Tintoiu, I. C., Sun, Z., & Bontas, E. (2020). *Liver Diseases: A Multidisciplinary Textbook*: Springer International Publishing. Springer Nature Switzerland AG.

Robert, H. D. (2004). *Textbook of veterinary pathophysiology. 5th Edn. Lowa, USA: Blackwell Publishing, pp 371-378.*

Roshdy, K., Morsy, K., & Abumandour, M. M. 2021. Microscopic focus on ependymal cells of the spinal cord of the one-humped camel (Camelus dromedarius): Histological, immunohistochemical, and transmission microscopic study. *Microscopy research and technique, 85*(4): 1238-1247.

Sasan, J. S., Sharma, A., Sarma, K., Suri, S., & Malik, M. R. 2017. A Quantitative Histological Study of the Liver of Pig (Sus Scrofa). *Indian Vet. J., 94*(3): 14-16.

Senoo, H. 2007. Kojima N, Sato M. *Vitamin A-storing cells (stellate cells). Vitam Horm, 75*: 131-159.

Stockert, J., & Colman, O. 1978. Toluidine blue staining on Epon semithin sections: effect of an oil differentiation. *Microscopica acta, 80*(2): 97-105.

Wisse, E., Braet, F., Luo, D., De Zanger, R., Jans, D., Crabbé, E., & Vermoesen, A. 1996 Structure and function of sinusoidal lining cells in the liver. *Toxicologic pathology, 24*(1): 100-111.