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Original Research

Histological Studies of the Liver in Dogs

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Abstract

The study was undertaken to document the histological details of the liver in adult dogs. The liver was collected from six freshly dead dogs of the spitz breed aged between 2-4 years (irrespective of sex) and studied for their histological details. The microscopic structure of the liver is conceptualized as the acinus and the lobule. The acinus was the smallest functional unit of the liver. The lobule was the structural unit of the liver. The liver was the compound tubular type of gland with a thin layer of connective tissue capsule found surrounding the parenchyma. The liver parenchyma consisted of capsule, septa and hepatic lobules with the arrangement of hepatocytes in radiating cords from centre to the periphery. Sinusoids were found between the hepatic cords of cells. Hepatocytes were large polyhedral-shaped eosinophilic cells. The sinusoids were lined with sinusoidal endothelial cells and contained Kupffer cells. The portal areas contained branches of the portal vein, hepatic artery and bile duct.

Keywords: Dogs, Hepatocytes, Histology, Kupffer Cells, Liver.

Introduction

The liver is the largest internal organ and has various functions like the production of bile and carbohydrates, protein and fat metabolism. In carnivores, the liver weighs about 3-5 percent of the body weight. The liver is also important for water-soluble vitamins, fat-soluble vitamins, iron and glycogen storage and also helps in the breakdown of hemoglobin and other toxic substances as per Spielman (2015). The liver in dogs was located in the intrathoracic portion of the abdomen. The caudate process is enlarged and contacts the right kidney. The liver in dogs was divided into five lobes namely left lateral, left medial, right lateral, right medial and caudate lobe with caudate and papillary process. The liver parenchyma was made up of a complex network of parenchymatous and non-parenchymatous cells, supported by connective tissue and supplied by portal vein and hepatic artery (Madhan and Raju, 2014). The hepatic lobule is the structural unit of the liver. The histological observations of the liver of guinea pigs were studied (Rajathi, 2021) and the comparative microscopic anatomy of the liver in different vertebrates namely rats, birds, lizards, frogs and fish were studied (Odokuma and Omokora (2015). Hence, this study was undertaken to document the histological details of the liver in adult dogs.

Materials and Methods

The liver was collected from six freshly dead dogs of the spitz breed aged between 2-4 years (irrespective of sex) from post-mortem examination and studied for their histological details. The liver was cut into small pieces routine histological processing was done and paraffin blocks were obtained. Paraffin sections of 4 to 5 µm thickness were taken from the blocks using a manual rotary microtome and stained using Haematoxylin and Eosin (Luna, 1968). Images were recorded using an image size recording system and a digiscope imaging system.

Results and Discussion

The microscopic structure of the liver is conceptualized as the acinus and the lobule. The acinus was the smallest functional unit of the liver that contained a small portal vein in the centre and a terminal hepatic (central) vein at the periphery. The acinus was divided into three zones namely zone 1, zone 2 and zone 3 (Fig. 1). Zone 1 was found around the portal tract, zone 3 was around the central vein and zone 2 was in-between the two zones. So, blood from the portal tract rich in oxygen and nutrients flowed through zones 1 and 2 and reached zone 3 with less oxygen and nutrients (Madhan and Raju, 2014). The lobule concept of demonstration of liver histology was a traditional type and was the structural unit of the liver. Here the central area is the central vein and the periphery is the portal tract (Fig. 1). The acinar zones 1,2 and 3 were visualized as periportal, mid-central and pericentral areas respectively.

The histology of the liver of male and female dogs was almost similar without any significant differences. The liver was the compound tubular type of gland with a thin layer of connective tissue capsule found surrounding the parenchyma. Similar results were also observed by Rajathi (2021) in guinea pigs. The connective tissue capsule was the dense irregular type with connective tissue cells and fibers (Fig. 2) as reported by Gupta *et al* (2017) in rabbits and Rajathi (2021) in guinea pigs. Faraj (2018) found a layer of smooth muscle fibres in the capsule of marsh harrier birds that was not observed as isolated smooth muscle fibres in the present study which may be due to species differences. Lobule separation was not clear and was seen only in the portal triad areas as stated by Gupta *et al* (2017) in rabbits and Rajathi (2021) in guinea pigs.

The liver parenchyma consisted of capsule, septa and hepatic lobules with the arrangement of hepatocytes in radiating cords from centre to the periphery (Fig. 3). Sinusoids were found between the hepatic cords of cells. The liver parenchyma was not clearly divided into lobules because of the absence of connective tissue septa and was observed only in the portal areas. The portal areas contained a portal triad with branches of the hepatic artery, portal vein and bile duct (Fig 4). The hepatocyte cords were one cell thick. Similar results were also noted by Gupta *et al* (2017) in rabbits and Rajathi (2021) in guinea pigs but in domestic chicken, Ellias *et al* (1971) observed a two-cell arrangement of hepatocytes.

Hepatocytes were large polyhedral-shaped eosinophilic cells with vacuolated cytoplasm and had spherical thick basophilic stained centrally located nuclei with single nucleoli (Fig. 5). Similar results were also observed by Rady and Amany (2016) in rats and Gupta *et al* (2017) in rabbits but the hepatocyte shape was oval in desert rodent (El-Salkh *et al*, 2008) and polygonal in guinea pigs (Rajathi, 2021). This may be due to species differences. Binucleated hepatocytes were rarely observed (Fig. 5) in the present study but were frequently seen in the liver of guinea pigs

(Rajathi, 2021) which may be due to species difference.

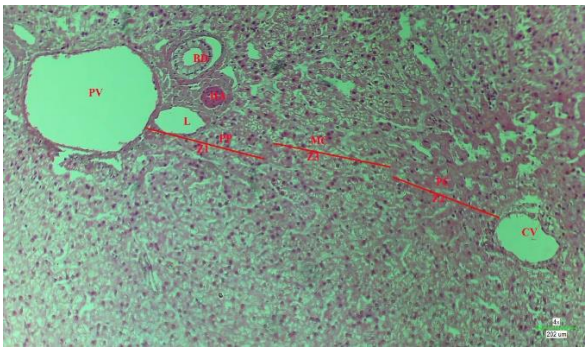

Fig. 1: Photomicrograph showing lobule and acinar model in dog liver.; PP -Periportal areas PC – Pericentral area MC – Midcentral area Z1, Z2, Z3 – Zone 1,2,3 PV – Portal vein, L – Lymphocyte, HA – Hepatic artery BD – Bile duct CV – Central vein H & E x 100

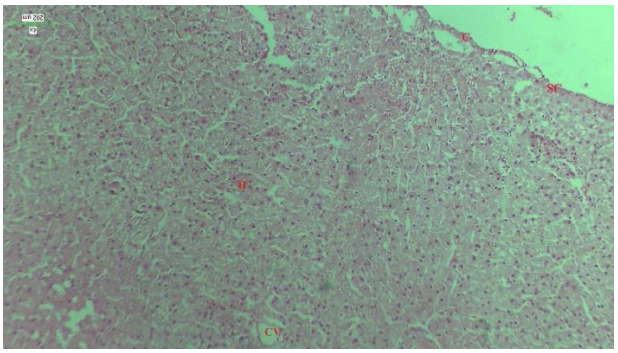

Fig. 2: Photomicrograph showing the capsule (C) of adult dog liver.; SC – Subcapsular layer CV – Central vein H – Hepatocytes H & E x 100

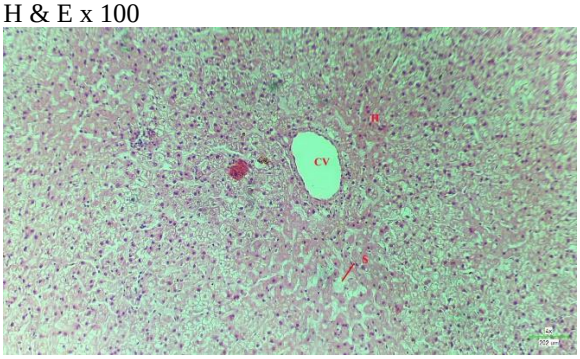

Fig. 3: Photomicrograph showing the Hepatocytes (H) were arranged in cords and found radiating from the centre to the periphery. CV – Central Vein S = Sinusoids H & E x 100

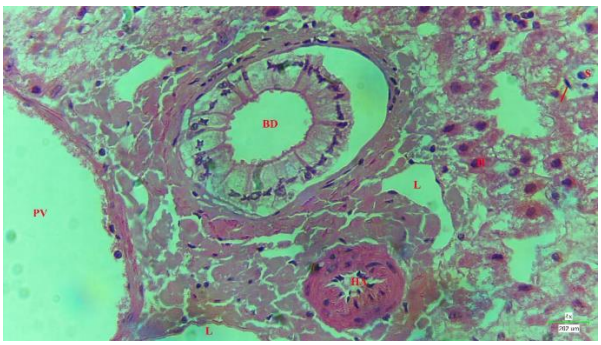

Fig. 4: Photomicrograph showing portal traid in adult dog liver. PV – Portal vein, HA – Hepatic Artery, BD – Bile duct, L – Lymphatics, H – Hepatocytes S – Sinusoids Arrow – Sinusoidal endothelial cells H & E x 400

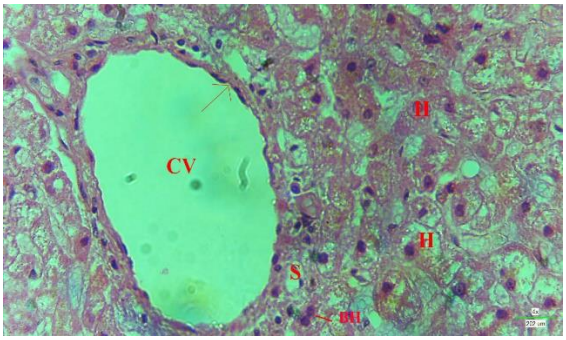

Fig. 5: Photomicrograph showing the hepatocytes (H) in adult dog liver.; CV – Central vein S – Sinusoids BH – Binucleated hepatocytes H & E x 400

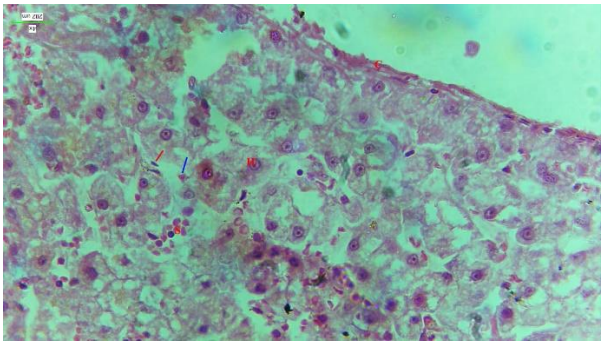

Fig. 6: Photomicrograph showing sinusoids (S) with Sinusoidal endothelial cells (Red Arrow) and Kupffer cells (Blue arrow).; C – Capsule H – Hepatocytes H & E x 400

The sinusoids were found between the cords of hepatocytes which were irregular thin-walled spaces with thin lumen. The lumen of sinusoids contained erythrocytes and leucocytes. The sinusoids were found to be lined with sinusoidal endothelial cells which were simple squamous in type with flat nuclei and also contained Kupffer cells within the sinusoidal lumen (Fig. 6). The Kupffer cells were large and polyhedral in shape, eosinophilic, vacuolated with many cellular processes and centrally located round-shaped nucleus. Similar results were also observed in Gupta *et al* (2017) in rabbits and Rajathi (2021) in guinea pigs but the shape of Kupffer cells was irregular in rabbits (Gupta *et al*, 2017) and guinea pigs (Rajathi, 2021) which may be due to feed variation.

The central vein was found in the centre of the pericentral region of the hepatic lobule with a wide lumen (Fig. 5) and was found to be lined with simple squamous epithelium in the tunica intima with a thin layer of smooth muscle fibres in tunica media and comparatively thick connective tissue fibres in tunica adventitia and was continuous with

pericentral hepatocytes. The epithelium of the central vein was also continuous with the epithelium of sinusoids. The occurrence of a central vein in the centre of the lobule follows the findings of El-Sakth *et al* (2008) in desert rodents and Hassan *et al* (2018) in rats.

The portal areas contained branches of the portal vein, hepatic artery and bile duct (Fig. 4). It also contained nerve fibres and lymphatics. Similar findings were also observed by El-Sakth *et al* (2008) in desert rodents and Hassan *et al* (2018) in rats.

The Bile ducts found in the portal areas were of different sizes small to large. The small ducts were lined with a simple cuboidal type of epithelium with an irregular nucleus in the centre with eosinophilic granular cytoplasm and were found to be surrounded by a thin layer of connective fibres. The large ducts were found to be lined with a simple high cuboidal type of epithelium with an irregularly shaped nucleus located in the basal part of the cell within the eosinophilic granular cytoplasm (Fig. 4). The large ducts were surrounded by a layer of connective tissue fibres and smooth muscles fibres. These were in concurrence with the findings of El-Sakth *et al* (2008) in desert rodents and Hassan *et al* (2018) in rats.

The hepatic artery was lined by simple squamous epithelium in the tunica intima with an internal elastic membrane and was found to be surrounded by tunica media with smooth muscle fibres and was surrounded by minute connective tissue fibres in the tunica adventitia layer (Fig. 4). The lumen was irregular and small. The proportion of smooth muscle fibres was more in the hepatic artery than in central and portal veins as stated by Rajathi (2021) in guinea pigs.

The portal vein possessed a wide lumen and was found to be lined with a simple squamous type of epithelium in the tunica intima and a thin layer of smooth muscle fibres in tunica media and thick tunica adventitia with connective tissue fibres (Fig. 4) as reported by Rajathi (2021) in guinea pigs.

Conclusion

The histological study of the liver of dogs was almost similar to the liver of vertebrates. The liver of birds showed more occurrence of binucleated hepatocytes which were found to be less in laboratory rodents and lagomorphs and were comparatively less in dogs. This shows the evolutionary pattern and type of food conception in different animals. The shape of the hepatocytes and Kupffer cells was also found to vary among species which may be due to feed variation.

Contribution by Authors

Equal contribution. All authors declared that 'written informed' consent was obtained from the approved parties for the publication of this article and accompanying images.

Conflict of Interests

There is no conflict of interest.

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