

Intrahepatic Distribution of The Hepatic Veins and Biliary Ducts In American Mink Liver (*Mustela vison*)

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With 3 figures

Received July 2016 , accepted for publication September 2016

Abstract

The aim of the study was to evaluate the intrahepatic ramification of hepatic veins and biliary ducts in American mink liver. Minks are not classical laboratory animals, but with the expansion of fur farming these animals have become available for many biomedical researches. Hepatic veins and biliary ducts of the mink liver were studied by dissection and injection corrosion technique. We determined three main hepatic veins: *vena hepatica sinistra* (VHS), *vena hepatica media* (VHM) and *vena hepatica dextra* (VHD). The largest branch is VHS, which drains blood from the left lateral and left medial lobe of the liver. The corrosion cast of the biliary ducts revealed two main excretory bile ducts, *ductus hepaticus sinister* (DHS) and *dexter* (DHD). The left bile duct (DHS) collects bile from the left lateral, left medial, quadrate lobe and the papillary process of the caudate lobe.

Keywords: American mink, liver, hepatic veins, bile ducts

Introduction

The American mink (*Mustela vison*) is a wild canid species native to North America, but with human intervention expanded its range to many parts of Europe and South America. It is one of the most frequently farmed animals for its highly valuable fur. The mink is also often used animal in biomedical research, experimental surgery, as indicator of environmental health, investigation of genetic diseases common in humans and animals, as a predictive model in toxicology (Padgett et al., 1968; Persson et al., 2012; Calabrese et al., 1992). The liver as the largest gland in organism has a both exocrine and endocrine function. Detailed knowledge of the liver blood supply and biliary drainage is important for understanding the blood flow, physiology and eventually pathological changes of the organ. Data about American mink liver and its blood vessels are scarce. Previous investigations about carnivores liver blood vessels include corrosion cast study of the canine hepatic veins (Uršič et al., 2014), anatomic and

ultrasonographic study of the hepatic veins in the dog (Cossu et al., 2001). The distribution of the biliary tree in dogs has been described in previous studies (Jablan-Pantić 1963; Bevandić et al., 1967). The aim of our study is to investigate the ramification of the hepatic veins and biliary ducts in mink liver and to compare our results with other canid species.

Materials and Methods

The study was carried out on 30 healthy and undamaged livers. The livers were obtained from animals farmed at "Kuna" farm near Sarajevo. After removal of the connective tissue by dissection we flushed the caudal vena cava in order to remove the blood clots from it. The casts were obtained using injection – corrosion technique (Tompsett, 1956) and dissection technique (Osman et al, 2008).

Dissection

For dissection technique acrylic monomer (Interacryl cold - Interdent, Slovenia) powder and solvent form were mixed in 1:2 proportions. The mass is coloured with polyurethane blue pigment for veins (Biodur, AC52). The hepatic veins were injected manually and left for 24 hours for complete polymerization process and after that were placed in 5% formalin solution for 10 days. Finally, hardened livers were dissected from the visceral side of the organ until the hepatic veins became visible.

Corrosion casts

After preparation we injected blue coloured Vinilyt into *Vena cava caudalis* to obtain hepatic veins casts. Bile ducts in the liver were injected from the gallbladder and cystic duct with yellow coloured Vinilyt. After injection, the livers were immersed in a bath of the concentrated commercial hydrochloric acid (36%) for 48 hours to remove the organic matter. The strong acid has completely corroded the organ tissue, while kept the plastic casts intact. Names of the branches of the hepatic blood vessels are given in accordance to current anatomical terminology – *Nomina Anatomica Veterinaria* (2005).

Results

Hepatic veins

Our results show that three main hepatic veins arise from the ventral portion of the left, right and central parts of mink liver. These hepatic veins we described as *vena hepatica sinistra* (VHS), *vena hepatica media* (VHM) and *vena hepatica dextra* (VHD). At the dorsal part of the liver these veins enter the *vena cava caudalis* (VCC).

Vena hepatica sinistra (VHS)

Left hepatic vein (VHS) represents the strongest tree and drains mixed blood from left lateral and left medial lobe of the liver. The diameter of VHS at its exit from the liver is 4,58 mm. The

VHS is composed of three veins arising from left lateral lobe and one vein from left medial lobe of the liver. Ventral branch from the *vv. hepaticae sinistrae laterales* goes laterally and terminates near the lateral border of the liver.

Vena hepatica media (VHM)

Middle hepatic vein (VHM) with a diameter of 4,08 mm goes ventrally and drains *lobus dexter medialis* and *lobus quadratus*. It gives off just one branch, which terminates in the quadrate lobe. The largest part of VHM continues ventrally and detach small branches which drain blood from right medial lobe. One more vein drains blood from the right medial lobe and is called *vena hepatica media accessoria*. This vein drains directly into *vena cava caudalis* between VHM and VHD.

Vena hepatica dextra (VHD)

The right hepatic vein (VHD) drains only one lobe of the liver, *lobus dexter lateralis*. It is directed laterally and then goes ventrally to terminate near the ventral border of the liver. Additionally, single short vein was located between the caudate process and the right lateral lobe. The diameter of the VHD near its opening was 4,75 mm.

Vena hepatica processus caudati

There are two small branches arising from the VCC. The first branch is quite short and goes ventrally. The second

branch near the dorsal border of the liver is longer and extends throughout the entire length of the caudate process.

Vena hepatica processus papillaris

In all corrosion casts there was one papillary process vein, which drained directly from the dorsal position into the VCC.

The bile ducts

The common excretory biliary duct (*ductus choledochus* – Dch), which ends in the duodenum, is formed by the *ductus hepaticus sinister* (DHS) and *ductus cysticus* (Dcy). This common duct formed in this way connects the excretory bile duct of the right lobe *ductus hepaticus dexter and sinister* (DHD, DHS). The diameter of the DHD was 0,97 mm and DHS was 1,10 mm.

Ductus hepaticus sinister (DHS)

The DHS collects bile from the left lateral, left medial, quadrate lobe and papillary process of the caudate lobe. At the beginning, the DHS gives off three branches that collect bile from the left lateral lobe (*lobi lateralis sinistri*). After 12 – 15 mm this branch receives from its ventral side a branch from the left medial lobe, *ramus lobi medialis sinistri*. This branch which is formed by two smaller ductules that extend throughout the left medial lobe. Next to this branch, the DHS receives one shorter vessel from the quadrate

lobe of the liver. Opposite to the *ramus lobi quadrati* DHS receives one ductile, which drains bile from the papillary process of the liver (*ramus processus papillaris*).

Ductus hepaticus dexter (DHD)

The DHD is formed of two smaller bile ducts that collect bile from the right medial and lateral lobes. The first duct is directed vertically and enters the right medial lobe (*ramus lobi medialis dextri*). The second larger duct enters the DHD laterally from the right lateral lobe. It is formed by the three ductules: *r. dorsalis lobi lateralis dextri*, *r. intermedius lobi lateralis dextri* and *r. ventralis lobi lateralis dextri*.

Discussion

The previous investigations on mink liver (Smith and Schenk 2000, Klingener 1979) revealed the basic data about the structure, lobation and location of the organ. Detailed knowledge of the liver blood vessels of the American mink is poorly described in the available literature. Earlier description of the liver vascular anatomy is available mostly for domestic animals (Arnautović et al. 1964; Carlisle et al., 1995; Cossu et al., 2001; Heath, 1968; Sleight and Thomford, 1970; Shirai et al., 2005; Tadjalli and Moslemy, 2007, Uršič et al., 2014). Recent studies of the liver focused on the internal ramification of the vessels to establish detailed know-

ledge of the vascular architecture necessary for the safe removal of diseased part of the liver. The corrosion cast studies allow us to investigate 3-dimensional vascular arrangement, which is crucial for analyzing the anatomical variations of the blood vessels within the organ. Because of the lack of knowledge about mink liver vascular arrangement, we compared our results with such results for other carnivores, mostly dogs.

The distribution and number of the hepatic veins are quite similar among mammals. Miller et al., (1964) reported that the left hepatic vein (VHS) represents the strongest tree, which drain blood from the left lateral, left medial, quadrate lobes and part of the right medial lobe of the dog liver. The VHM according to these authors drains right lateral and part of the right medial lobe. The right hepatic vein (VHD) drains only the caudate process of the dog liver. Uršič et al. (2014) reported that the left hepatic vein drained both lateral and medial lobes, while the medial vein collected blood from the right medial and quadrate lobes. Our observations were largely in accordance with these statements. However, we found additional vein that drained the right lateral lobe along with VHD. Similar ramifications of the hepatic veins in dogs were described by Cossu et al. (2001). Their findings corresponds with ours regarding the position of the blood vessels and lobation, but these authors didn't use

appropriate nomenclature for these veins.

The present study revealed that the common excretory biliary duct was formed by the *ductus hepaticus sinister* (DHS) and *ductus cysticus* (Dcy), which then connects with the excretory bile duct of the right lobe *ductus hepaticus dexter* (DHD). Similar results were found in dog (Bevandić et al., (1967), but the distribution among lobes wasn't in accordance with our results. We found that DHS drained bile from the left lateral, left medial, quadrate lobes and papillary process of the caudate lobe. Bevandić et al., (1967) reported that this bile duct drained the left lateral and medial lobes of the dog liver. Also they reported that the cystic duct received branches from the papillary process, quadrate and right medial lobes of the liver. In our results the cystic duct drained bile only from the gallbladder.

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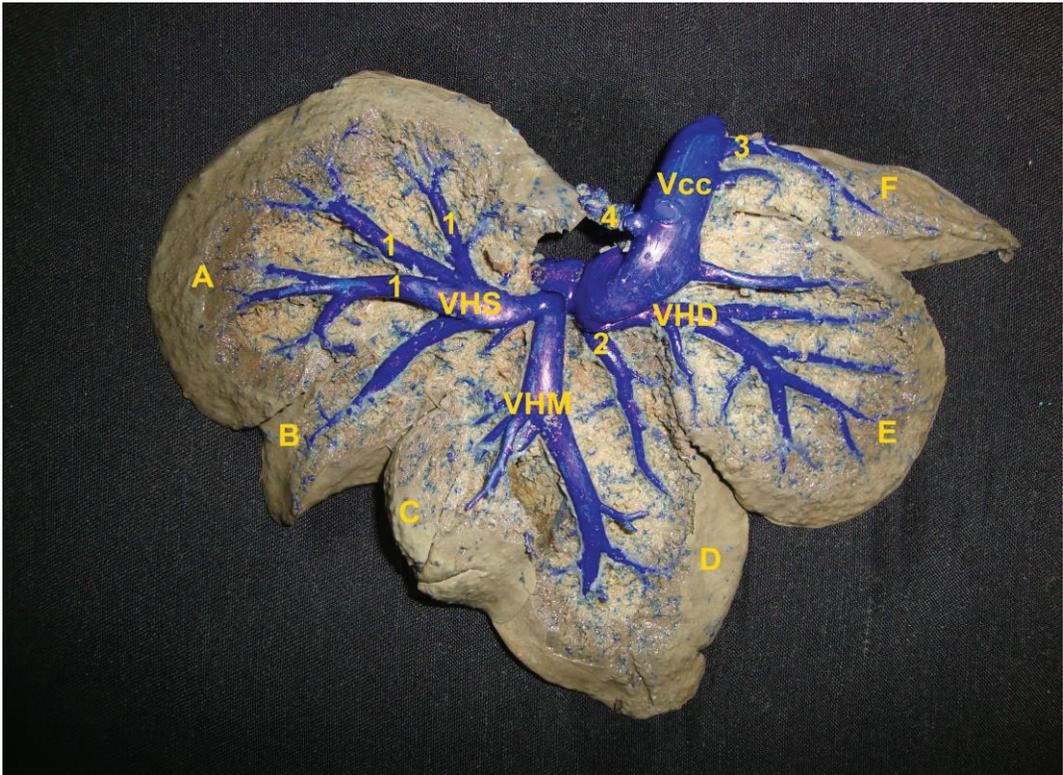


Fig. (1): Intrahepatic ramification of the hepatic veins (dissection technique)

A Lobus hepatis sinister lateralis, B Lobus hepatis sinister medialis, C Lobus quadraus, D Lobus hepatis dexter medialis, E Lobus hepatis dexter lateralis, F Lobus caudatus, Vcc Vena cava caudalis, VHS Vena hepatica sinistra, VHM Vena hepatica media, VHD Vena hepatica dextra

1 Vv. hepaticae sinistrae laterales, 2 V. hepatica media accesoria, 3 V. hepatica processus caudati, 4 V. hepatica processus papillaris

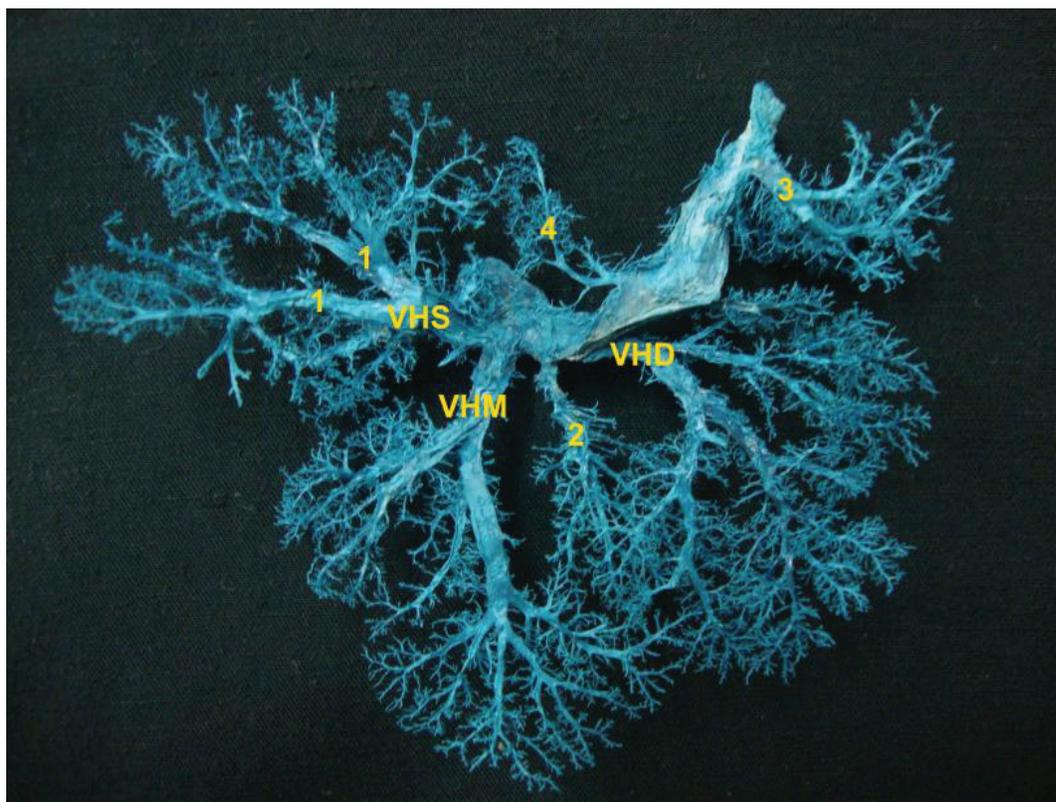


Fig. (2): Intrahepatic ramification of the hepatic veins (corrosion technique)

Vcc Vena cava caudalis, VHS Vena hepatica sinistra, VHM Vena hepatica media, VHD Vena hepatica dextra

1 Vv. hepaticae sinistrae laterales, 2 V. hepatica media accesoria, 3 V. hepatica processus caudati, 4 V. hepatica processus papillaris

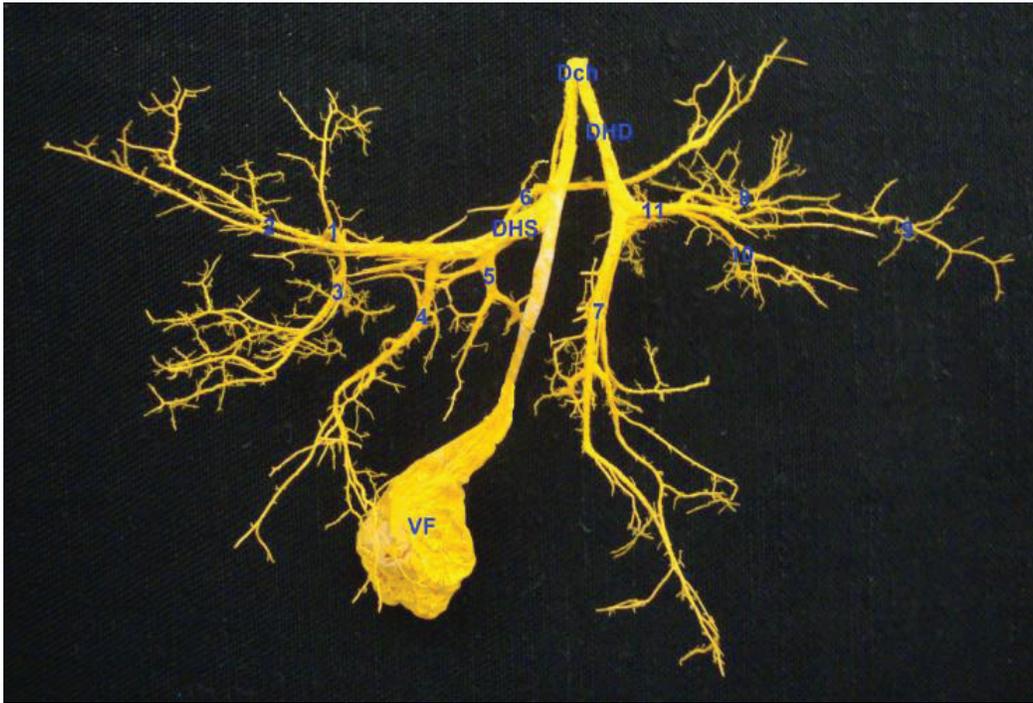


Fig. (3): Corrosion cast study of the biliary ducts in mink liver

Dch Ductus choledochus, DHS Ductus hepaticus sinister, DHD Ductus hepaticus dexter, VF Vesica felea,

1 R. dorsalis lobi lateralis sinister, 2 R. intermedius lobi lateralis sinister, 3 R. ventralis ventralis lobi lateralis sinister, 4 R. lobi medialis sinister, 5 R. lobi quadrati, 6 R. processus papillaris, 7 R. lobi medialis dextri, 8 R. dorsalis lobi lateralis dextri, 9 R. intermedius lobi lateralis dextri, 10 R. ventralis lobi lateralis dextri