

# Anatomical Structure of Caudal Venae Cavae and its Anastomosis with Hepatic Veins in the Buffalo (*Buballus Bubalis*)

Hamid Karimi<sup>1,\*</sup>, Ghaffar Ardalani<sup>2</sup> and Alireza Mozzaffari<sup>3</sup>

<sup>1</sup>*Veterinary Anatomy, Faculty of Veterinary Medicine, University of Tabriz, Tabriz, Iran*

<sup>2</sup>*Veterinary Anatomy, Faculty of Veterinary Medicine, Urmia University, Iran*

<sup>3</sup>*Faculty of Veterinary Medicine, Iran*

**Abstract:** The liver is the largest gland in the digestive system. Most parts of the liver are placed in the right region of the abdominal cavity and fixed by special ligaments, arteries and veins. The blood of the digestive system is drained into the liver by the portal vein. In this survey, the relationship between portal vein with hepatic veins, types of hepatic veins, manner of drainage of hepatic veins and also manner of drainage of the portal vein into caudal vena cava are studied.

Thirty healthy livers of buffalo are selected from Urmia industrial slaughterhouse and biometrical studies performed on them. Also, the latex injection is used for observation of anastomosis of different veins in the liver.

Results of liver biometry are followed:

Average of weight of liver =  $4380 \pm 1173/30$ gr, average of length of liver =  $467.5 \pm 47/00972$ mm, average of wide of liver =  $270.8 \pm 38/90934$  mm, average length of gallbladder =  $109.66 \pm 13/7673$ mm, average of wide of gallbladder =  $70.4 \pm 17/7426$ mm, average of caudal vena cava canal =  $151.06 \pm 28.6854$ , Average of diameter of portal vein =  $30.93 \pm 4.4430$  and average of caliber of portal vein in entrance to liver =  $39.26 \pm 6.2098$ .

The liver veins were short veins, which are occupied parenchyma of the liver. These veins are received more branch of small veins. All of these veins were draining into abdominalolateral wall of inter hepatic part of the portal vein. Results of this research are showed which inter hepatic veins have a different diameter. Rang of this diameter was from 0.5 to 3 mm or more. Interhepatic veins were classified according to the size of their calibre into three groups, large intrahepatic veins (they were generally more 3mm in diameter), intermediate interhepatic veins (they were 1to 3 mm in diameter) and small interhepatic veins (they were less 0.5 to 1 mm in diameter). Results of this study are showed which the average number of large foramen were 3.8, the average number of medium foramen was 8.3, and an average number of small foramen was 36.56. The studies on derivatives of portal vein on the buffalo liver have appeared which portal veins are dividing three principals trunks (left, middle and right). Left principle trunk is dividing into three branches (proximal, middle and distal). The outlet of all three types of hepatic veins had a valvular fold in entrance into caudal vena cava, which is named operculum the direction of this valve was toward the heart. Also, these research results have appeared which liver of buffalo is weightier and bigger than cattle.

**Keywords:** Anatomy, Buffalo, Caudal vena cava, Portal vein.

## INTRODUCTION

The buffalo belong to the order Artiodactyls, the suborder Ruminatae, the family Bovidae and the sub-family Bovini. Three group animals were described in the sub-order Bovini. They are Bovinal (cattle), Bubaline (Asian buffalo) and Syncerina (African buffalo) [1]. The buffalo was domesticated many years ago that its exact time is unknown. Archaeology studies showed which buffalo domestication was performed 2500 B.C. There is not enough information about Iranian buffalo [2]. The buffalo has a vital role in living state and economic condition of millions of poor villager, especially in Asia [3]. The buffalo is multi propose animal, which it has height quality digestive system. Buffalo's digestive system can produce enough energy of low-quality foodstuff [4].

The liver is the largest gland in an animal's body [5]. The liver has many different functions; for example, storage of glycogen, detoxification, protein synthesis and est [5]. It has two circulatory systems which are nutritional and functional circulatory system [1-4, 6]. The hepatic artery is a small vessel, which is arising from the celiac artery and enters the liver on the visceral surface. This vessel has a nutritional role in the liver [1, 2, 4, 6]. The portal vein has a functional role in the liver. This vein is receiving blood from stomach, pancreas, spleen, small intestine and significant parts of the large intestine [1, 2, 4, 6]. The portal vein enters the liver in the hepatoduodenal ligament. It divided into a short right and a long left branch [3, 4, 7]. Inside the liver, portal venous branches give rise to a large array of hepatic sinusoids from an extensive capillary bed that veins branches drain them. These veins branches give rise to a variable number of hepatic veins that enter the caudal vena cava [1, 3]. The hepatic veins have a different calibre [4]. Buffalo not only has a vital role in daily production in Iran but also much anatomical structure of this animal is unknown yet.

\*Address correspondence to this author at the Veterinary Anatomy, School of Veterinary Medicine, University of Tabriz, Tabriz, Iran; Tel: +9836378743; Fax: +9836378743; E-mail: karimi@tabrizu.ac.ir

Hepatic veins circulatory system is important because the absorbed blood of digestive system drain in liver veins totally thus liver veins are suitable and final place for some of the parasite. This research studied many different types of veins and blood drainage of the liver in these animals.

In this research, the weight and size of the liver, portal vein, its branches, type of hepatic vein depend on the size of calibre and manner of drained to caudal venae cavae were studied.

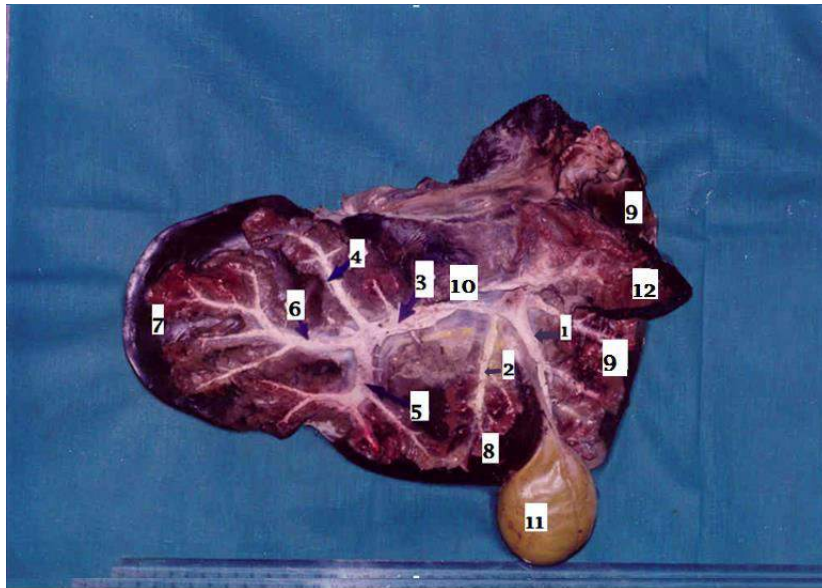
## MATERIALS AND METHODS

Thirty healthy livers of buffalo were collected from West Azerbaijan industrial slaughterhouse. Weight, length, width and thickness of the liver, weight, length, width and thickness of the gall bladder, the calibre of the inlet of the portal vein, calibre of inlet and outlet of caudal venae cavae are measured. Also, a number of foramina that exist in the floor of caudal vena cava were countered. Later, in 24 cases, the latex was injected into the portal vein for observation of anastomosis of hepatic veins with caudal vena cava,

then the injected livers were dissected, and the hepatic veins anastomosis was studied. In 6 other cases, the gelatin was injected into the portal vein, and the hepatic veins anastomosis was studied.

## RESULTS

This research observation appeared that portal veins have a three-principle trunk in entrance of the liver (right, left and middle trunk). Left trunk toward left lobe and divided into three branches, dorsal, middle and ventral branch. These branches divided into secondary and accessory branches. Because left lobe was huge and left trunk had very distributed branch. The average length of the left branch was 27 mm. The average length of middle accessory branch 71 mm, dorsal accessory branch 82 mm and ventral accessory branch 53 mm were measured. The length of the middle principle trunk was 84 mm that entered into the middle lobe of the liver. The right principle trunk divides into two accessory branches that were 93 and 83 mm. A small branch (average length 31mm) arose from a portal vein that entered into a caudate lobe. This branch was not permanent in all samples (Figure 1).



**Figure 1:** visceral surface of the liver of the buffalo.

The manner of enters portal vein into the liver of buffalo.

1- Right principles trunk of the portal vein, 2- Middle main trunk of the portal vein, 3-Left principles trunk of the portal vein, 4- Proximal branch of left principle trunk of portal vein, 5- The middle branch of the left main trunk of the portal vein, 6- Distal branch of the left main trunk of portal vein 7-Left lobe, 8- Quadrate lobe, 9-right lobe, 10- Papillary process, 11-Gall bladder.

**Table 1: Biometric Results of Liver**

Average Weight	Average Length	Average Wide	Average Thickness
4380±1173/30gr	467.5±47/00972mm	270.8±38/90934 mm	110.5±14/10466mm

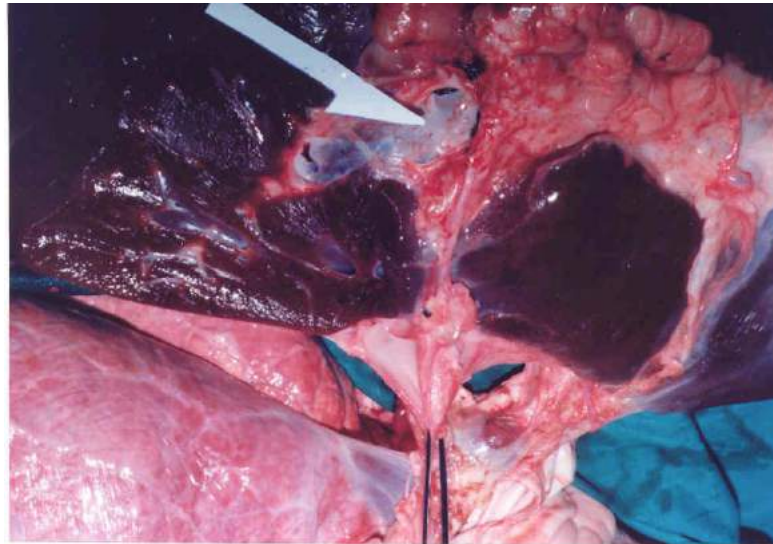
Biometric results of the livers and gall bladder were summarized in Tables 1, 2.

**Table 2: Biometric Results of Gall Bladder**

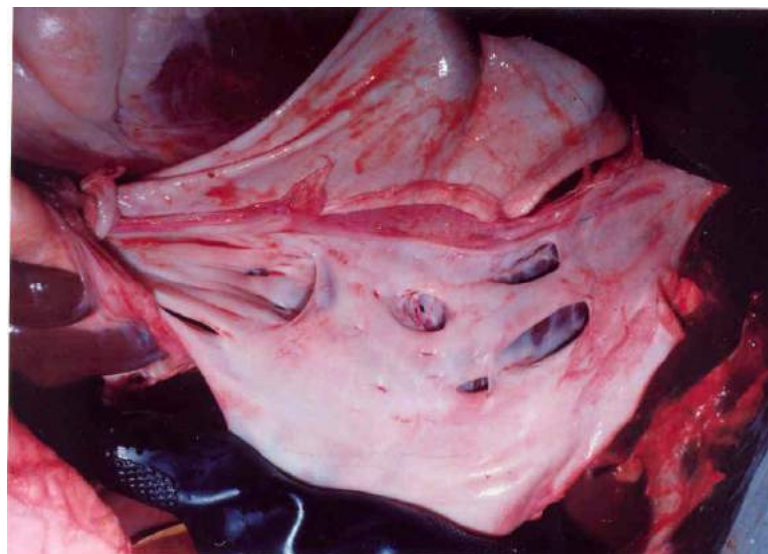
Average Length	Average Wide
109.66±13/7673mm	70.4±17/7426mm

Also, caudate lob received many small branches from the portal vein. The length of caudal venae cavae in liver parenchyma was 151 mm. The average of the calibre of the inlet of caudal venae cavae was

39.26±6.2098 and outlet calibre was 42.43±6.5689 mm. Hepatic veins were drained into caudal venae cavae in across it in the liver. These study observations showed that hepatic veins have a valve as operculum in dorsal position on themes outlet. Operculum opened toward the heart. Hepatic veins originated from hepatic lobules and drained into caudal vena cava. The hepatic veins had different calibre in themes outlet. Based on the calibre of the outlet of hepatic veins, these veins characterized by 3 groups (small, medium and large hepatic vein) (Figure 2). The number of small hepatic veins was more than others.



**Figure 2:** Visceral surface of the liver of the buffalo. Marker show inlet of the portal vein.



**Figure 3:** The floor of caudal vena cava among liver parenchyma. The outlet of hepatic veins and different calibre of them is observed.

## CONCLUSION

The liver is the largest gland in the animal's body [4]. The shape, the topographical characteristics and the ovulation of this organ are different in animals [1-3, 6, 7]. The liver has two important blood supply that are functional and nutritional blood supply. Hepatic artery already has a nutritional function, and the portal vein is making functional blood supply of the liver. Portal veins are collecting blood from stomach, pancreas, spleen, small intestine and major parts of the large intestine and then enter the liver [1-3, 6, 7].

In human, the portal vein has two branches in the visceral surface of the liver when it enters the liver. They are right and left branches which enter the right hepatic lobe and the left branch, longer but of smaller calibre branches into caudate, quadrate and left lobe [4]. In the horse, Sisson reported that portal vein divides into lobular branches, but he doesn't report several interlobular branches. Interlobular branches form plexus of capillaries (sinusoids) in the lobules and give rise to a central vein. Central vein emerges from bases the lobules and joins the sublobular veins; the latter unite to form hepatic veins. There are 4 hepatic veins in horses [5, 6]. In the ox, portal vein divides into two branches, a very short right branch and a long left branch. Right branch divides immediately into 4 or 5 secondary branch. The left branch runs at first in the long axis of liver from the porta toward the left lob then lies very close to visceral surface between the caudate and quadrate lobes, that covered by the papillary process, fat and hepatic lymph nodes [5, 6]. Ranjbar, R., and L.A. Ghadiri (2011) reported that Iranian buffalo hepatic vein divided into two branches as left and right [8]. Ellenport reported that caudal vena cava receives two or three large hepatic veins in dogs [3]. Biswas, P. *et al.* reported that portal vein in pig has two central right and left branch as it is observed in ox [9].

In this research, the hepatic veins were characterized depending on their calibre into 3 groups: small, medium and large hepatic vein.

Results of this research showed which portal vein divide three principle vein trunks (right, middle and left

the main trunk). The right principle trunk arose two primary branches that enter right lob. The left principle trunk divides into three primary branches (proximal, middle and distal). Primary branches divided into secondary and accessory branches). Habel reported that portal vein divides a very short right branch and a long left branch in cattle. They have secondary branches, which lie for the most part close of the visceral surface. The right branch divides into four or five secondary branches – branch to the caudate process, right dorsal branches, one or more right intermediate branch toward left lobe. In supply left lobe, quadrate lobe and quadrate lobe [2, 6]. The comparison between the architecture of derivatives portal vein of the liver of ox and buffalo can appear different between these two animals.

## REFERENCES

- [1] Sisson S. Equine digestive system. In: Sisson and Grossman's The anatomy of the domestic animals, Edited by Robert Getty, Fifth Edition, W.B. Saunders Company 1975; Vol. 1: pp. 492-496.
- [2] Schummer A, Wilkans BH, Vollmerhaus B, Habermehl KH. The circulatory system, the skin and the cutaneous organs of the domestic mammals, Translated by Walter G. *et al.* First edition, Verlag Paul Parey, Berlin 1981; pp. 260-261. <https://doi.org/10.1007/978-1-4899-7102-9>
- [3] Ellenport CR. Carnivore digestive system. In: Sisson and Grossman's The anatomy of the domestic animals, Edited by Robert Getty, Fifth Edition, W.B.Saunders Company, Philadelphia 1975; Vol. 2: pp. 1554-1556.
- [4] Warwick W, Bannister D. Gray's anatomy, Thirty-Seventh Edition, Churchill Livingstone, Edinburgh, 1989; pp. 818-823.
- [5] Junqueira LC, Carneiro J, Kelley RO. Basic histology, Seventh edition, Appleton & Lange, Printed in USA 1992; pp. 320-323.
- [6] Habel RE. Ruminant digestive system. In: Sisson and Grossman's The anatomy of the domestic animals, Edited by Robert Getty, Volume 1, Fifth Edition, W.B. Saunders Company, Philadelphia 1975; pp. 908-913.
- [7] Evans HE, Delahunta A. Guide to dissection of the dog, Fifth edition, W.B. Saunders Company, Philadelphia 2000; pp. 213.
- [8] Ranjbar R, Ghadiri LA. Observation of intrahepatic branching pattern of the portal vein in water buffalo of Iran. *Asian J Anim Vet Adv* 2011; 6(5): 508-516. <https://doi.org/10.3923/ajava.2011.508.516>
- [9] Biswas P, Ray S, Das P, Saren S, Shee A, Banerjee A, Md. Islam M. Gross Anatomical and Histomorphological Studies on Liver with Ramification of Portal Vein and Hepatic Artery in Ghungroo Pig. *Int J Curr Microbiol App Sci* 2018; 7(6): 2955-2965. <https://doi.org/10.20546/ijcmas.2018.706.348>